Review of the Contributions of UAVs and Artificial Intelligence in Intelligent Transportation Systems

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***Abstract*— Urban transport infrastructures are continuously faced with challenges such as traffic congestion, accidents, pollution, wear and tear. Traditional traffic management technologies (such as traffic lights and static cameras) have shown their limitations, whereas Intelligent Transportation Systems (ITS) integrating the Internet of Things, drones, and Artificial Intelligence offer powerful tools to proactively and efficiently address these issues. ITS aim to enhance the efficiency, safety, and sustainability of transportation networks by leveraging advanced technologies. In this context, drones and AI play a central role in tackling the growing challenges of urbanization, increasing traffic, and the need for smarter infrastructures. This work reviews the contributions of Unmanned Aerial Vehicles and Artificial Intelligence in Intelligent Transportation Systems. A literature review is conducted to identify similar studies and assess the state of research on the topic. An analysis of the various applications of IoT, drones, and AI provides an evaluation of their contributions to ITS. Despite significant challenges, drones and AI have revolutionized the field of intelligent transportation.**

Keywords—Artificial Intelligence, Contribution, Intelligent Transportation Systems, Review, UAV.

I. INTRODUCTION

Uncontrolled urbanization has introduced new challenges for cities, such as significant energy demand, pollution, intense mobility, and social disparities. These emerging challenges place considerable strain on urban infrastructures, particularly transportation networks. High levels of traffic influx lead to various issues such as road congestion, an increase in accidents, and disorderly parking. Traditionally, cities have responded to growing mobility demands by diversifying transportation services through the development of various road infrastructures. Additionally, with the advent of modern technologies, Information and Communication Technologies (ICT) have been integrated into transportation systems, forming what are now known as Intelligent Transportation Systems (ITS). Effective management of contemporary road transport networks thus heavily relies on ITS. These systems encompass a wide array of information systems, networks, and electronic devices used to manage and operate transportation and traffic. They are based on advanced technologies designed to collect, analyze, and share real-time data with the goal of enhancing safety, optimizing traffic management, and improving driver experience. The primary goal of traffic monitoring is to gather data to assess traffic networks. Existing technologies for traffic monitoring include inductive loop detectors, micro-sensors, and surveillance cameras. However, these solutions are fixed, slow, limited in coverage, costly to operate and maintain, and thus not very cost-effective. As for remote sensing satellites, they are widely used for aerial photography and navigation. While they can provide a broad view for capturing traffic data, their high cost and technical limitations (e.g., spatial resolution) make them impractical for many applications [1]. Unmanned Aerial Vehicles (UAVs) are employed in a multitude of applications in the modern era, particularly in control and monitoring tasks associated with the development of smart cities, due to the significant advantages they offer. These advantages include intelligent altitude and location management, dynamic coverage, real-time data collection and processing, obstacle avoidance, and object monitoring. As transportation systems become increasingly complex, vehicle detection from drone imagery has grown to be critically important.

Thanks to recent advancements in computer vision, Machine Learning, and Deep Learning techniques, coupled with the availability of large datasets, faster graphical processing units (GPUs), and advanced algorithms, computers are now capable of detecting, recognizing, classifying, and tracking multiple objects in images or videos. Aerial images or videos are an excellent choice for these tasks as they provide a better vantage point and are relatively easy to capture and deploy.

Thus, ITS leverage big data and the potential of Machine Learning to develop numerous applications, such as traffic flow prediction, travel time estimation, and intelligent parking management [2]. What are the contributions of Artificial Intelligence (AI) and drones to the advancement of Intelligent Transportation Systems (ITS)? While scientific studies have investigated the use of drones, Machine Learning techniques, and Deep Learning in transportation, few studies have specifically examined the combined contributions of drones and AI in intelligent transportation.

This study reviews the contributions of Unmanned Aerial Vehicles (UAVs) and Artificial Intelligence (AI) to

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Intelligent Transportation Systems (ITS). A collection of recent scientific studies on intelligent transportation systems was conducted to assess the evolution of ITS. Subsequently, the use of drones in data collection and target tracking within transportation contexts is evaluated based on prior research. The role of AI algorithms in processing transportation data is analyzed to identify research gaps and deepen understanding in this area.

The key contributions of this review are as follows: (1) It provides an overview of scientific research on the potential of intelligent transportation systems. (2) It offers an analysis of the main contributions of drones and AI algorithms in urban transportation. The remainder of this paper is organized as follows: Section 2 presents related researches conducted on the subject. Section 3 provides an overview of the potential of intelligent transportation systems in smart cities. Section 4 discusses drone applications and the use of AI algorithms in intelligent transportation. Section 5 is dedicated to discussing the contributions of drones and Artificial Intelligence, as well as the challenges that remain.

II. RELATED WORKS

Intelligent Transportation Systems (ITS) have been the subject of numerous scientific studies. More specifically, some works have focused on the state-of-the-art regarding intelligent transportation in smart cities. These studies have taken the form of surveys, literature reviews, or systematic literature reviews. From the literature, two major categories of research emerge: the first category of literature reviews addresses the role of the Internet of Things (IoT) in intelligent transportation. Leduc G. [3] conducted a review of road traffic data collection methods. This work identified two groups of methods: conventional ”in situ” technologies, which include intrusive and non-intrusive methods, and Floating Car Data (FCD) techniques, which include GPS and cellular technologies such as GSM/GPRS/UMTS/CDMA. The review also covered different types of traffic data, such as speed, location, direction, congestion index, Average Annual Daily Traffic (AADT), Vehicle Kilometers Travelled (VKT), and more. Nellore and Hancke [4] conducted a survey on urban traffic management systems utilizing wireless sensor networks. Their research focused on recent urban traffic management systems for priority-based signaling and congestion reduction. They developed a taxonomy of various traffic management systems designed to mitigate congestion. After collecting relevant similar studies, the work reviewed various types of wireless sensors, their applications, and the wireless communication technologies used in intelligent transportation. Oladimeji et al. [5] conducted a comprehensive overview of technologies and applications in intelligent transportation. Their work involved an exhaustive examination of research on Intelligent Transportation Systems (ITS) and their applications, focusing on the diverse technologies employed. They explored communication technologies (Wi-Fi, Bluetooth, and cellular), architectures, and protocols related to ITS. The study also evaluated the opportunities and challenges associated with deploying various technologies for intelligent transportation, with particular emphasis on IoT and machine learning techniques. Other authors [6] investigated the role of the Internet of Things (IoT) in ITS. They reviewed the various contributions of IoT to transportation, such as traffic optimization, clustering and control systems, resource protection, and target localization. They concluded that integrating IoT into ITS could enhance traffic optimization performance. IoT devices enable faster collection, storage, and processing of traffic-related data, facilitating the resolution of traffic issues. Jurczenia et al. [7] conducted a survey on vehicular network systems in road traffic management. Their work provided a detailed analysis of a wide range of road traffic management architectures from the perspective of the location and operation of computing units. Their approach involved identifying key use cases for traffic management applications and services, classifying and analyzing traffic management architectures, and discussing the limitations of each architecture. The second category of related work focuses on traffic management using drones and Artificial Intelligence. Authors such as Bisio et al. [8] and Butila et al. [9] produced systematic literature reviews on road traffic management and analysis using drones. Bisio et al. [8] focused on vehicle detection, tracking, and counting fundamental elements for addressing traffic congestion, occupancy rates, and vehicle speed estimation. They also examined the challenges posed by the diversity of drone devices and summarized the solutions deployed in the literature, discussing future trends in developing comprehensive traffic monitoring systems for smart cities. Butila et al. [9] reviewed scientific contributions to the application of drones in civil engineering, particularly in traffic monitoring. Their results highlighted a growing trend in recent years of drone use in transportation, with China leading in the number of applications and the development of data acquisition equipment. Regarding flight mechanisms, rotary wing drones especially quadcopters were preferred for data collection. Various image processing methods have been proposed for vehicle detection and tracking, with Deep Learning approaches becoming increasingly favored. Their study found that most identified works focus on vehicle detection, tracking, trajectory extraction, collision prediction, and evaluation. AI algorithm applications in transportation data processing have also been a significant focus of literature reviews. Liu et al. [10] examined computer vision techniques for vehicle detection and tracking in ITS. Their work provided a comprehensive review of computer vision methods for detecting and tracking vehicles. Detection methods based on intrinsic vehicle characteristics and motion-based detection techniques were detailed in their study. For tracking, approaches included vehicle representation and methods based on prior knowledge, with computer vision playing a central role in all methods studied. Azad et al. [11] reviewed the application of Machine Learning in ITS, while Srivastava et al. [12] focused on the application of Deep Learning in vehicle detection from drone imagery. These studies reviewed various algorithms and their applications in transportation data processing. Applications ranged from target and anomaly detection in transportation to driving assistance, target tracking, and event prediction (traffic flow, congestion, speed, travel time, risks, etc.).

This state-of-the-art review highlights the extensive body of research on applying drone and AI technologies in ITS. Earlier studies explored IoT’s contributions to ITS, while more recent ones examined the application of Unmanned

Aerial Vehicles (UAVs) and Deep Learning and Machine Learning techniques in transportation. However, few studies have conducted a combined review of the contributions of both UAVs and AI to ITS. The field of machine learning algorithms applied to drone collected traffic data is vast and remains underexplored. This work aims to catalog the various contributions of drones and Artificial Intelligence to Intelligent Transportation Systems.

III. SMART TRANSPORTATION IN SMART CITIES

In the era of globalization and modernity, the future of urban development relies on smart cities that leverage technology and data to optimize activities and services [13]. By integrating technologies such as Internet of Things (IoT), Internet of Vehicles (IoV), broadband networks, and AI into urban transportation systems, cities have the potential to optimize the use of traffic data, reduce transportation issues, lower operational costs, and enhance user well-being [14].

A. *Overview of Intelligent Transportation Systems (ITS)*

An Intelligent Transportation System (ITS) is an interactive system for collecting, processing, and disseminating information applied to transportation. It is based on the integration of information and communication technologies into the infrastructures and vehicles used, with the aim of improving the management and operation of transport networks as well as the services associated with them [3]. ITS are deployed in the transportation sector to optimize the management, safety, and efficiency of transport infrastructures. These systems enable the management of mobility-related externalities (noise, pollution, congestion), improve the comfort and safety of goods and people, and optimize the management of infrastructures and public policies related to the entire transportation system [15].

Fig. 1. Intelligent transportation systems [15].

B. *Objectives of Intelligent Transportation Systems (ITS)*

The deployment of Intelligent Transportation Systems (ITS) aims to address the social and environmental challenges arising from the increasing volume of road traffic, economic development, and mobility demands (Fig.1). More specifically, ITS are designed to:

- Improve road safety by reducing accidents through prevention, detection, and real-time alert systems.
- Optimize traffic flow by minimizing congestion and regulating traffic in real time.
- Reduce environmental impact by lowering greenhouse gas emissions through more efficient travel.
- Facilitate access to information by providing real-time data to users for better trip planning.
- Enhance user experience by making travel more comfortable and faster.

C. *Components of Intelligent Transportation Systems (ITS)*

STIs are composed of technologies and applications [16] (Fig.2).

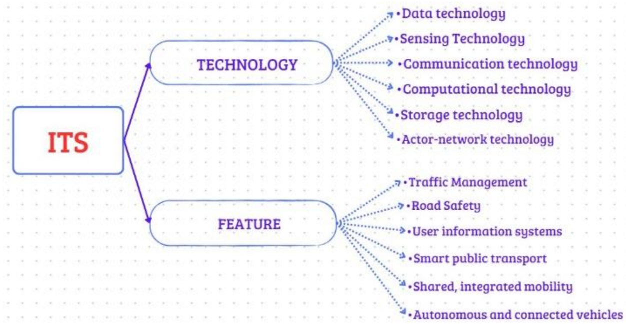

Fig. 2. Components of ITS [16], [17].

1) *ITS technologies:* Intelligent transportation systems leverage a variety of technologies ranging from basic traffic light management to speed cameras, video surveillance, and more complex management that integrates real-time information. These technologies, used to enhance the management, safety, and efficiency of the transport network, include the following:
   - Data: The data used by ITS come from various sources and are considered Big Data because they are varied, voluminous, and transmitted at high speed. Often requiring preprocessing, they are collected by sensors and enable the prediction of trends and anticipation of transport issues.
   - Sensors: They are primarily composed of components of the Internet of Things and are used to collect and transmit data. Traditional sensors have limited functionalities (Table I) and include pneumatic road tubes, piezoelectric sensors, magnetic loops, passive and active infrared sensors, passive magnetic sensors, microwave radar, ultrasonic sensors, and cameras [3], [18]. GPS and UAVs have later been used as popular means of collecting dynamic traffic data [1], [19]. The types of sensors and their functionalities are summarized in Table I.

TABLE I
SENSOR TYPES AND FUNCTIONALITIES [3], [4], [20], [21]

Sensors	Typ	Count	Speed	Class	Track	I/V
Inductive Loop	I	Y	Y	Y	N	N
Magnetic	I	Y	Y	Y	N	N
Pneumatic Tube	I	Y	Y	Y	N	N
Passive Infrared	N	Y	Y	Y	N	N
Active Infrared	N	Y	Y	Y	N	N
Microwave Radar	N	Y	Y	Y	N	N
Ultrasonic	N	Y	N	N	N	N
Passive Acoustic	N	Y	Y	Y	N	N
Static camera	N	Y	Y	Y	Y	Y
GPS sensor	N	N	Y	N	Y	N
Satellite	N	Y	Y	Y	Y	Y
UAV	N	Y	Y	Y	Y	Y

- Communication Technologies: Intelligent Transportation Systems (ITS) rely on communication networks for interaction and cooperation. The connection of road infrastructure to vehicles and vehicles to each other can be achieved through a single system called Cooperative Intelligent Transportation System (C-ITS) or Vehicle-to-Everything (V2X) communication [4]. Using embedded sensors, vehicles automatically generate messages about situations they encounter (e.g., slippery roads, emergency braking) and broadcast them to the surroundings. These messages can be received by other vehicles (V2V) and road operators (V2I). Road operators can also transmit information regarding roadworks, winter maintenance, or traffic conditions to equipped vehicles (I2V). The system can aim to provide simple driver information or be integrated with delegated driving functionalities. Information exchanges between vehicles and pedestrians (V2P or P2V) can also be envisioned (Fig. 3) [17]. Various ITS communication technologies are used, the main ones being Dedicated Short-Range Communications (DSRC), Wireless Sensor Network (WiMAX), Mobile Telephony, Radio Wave, Probe Vehicle, ITS-G5, LTE, and 5G [16].

Fig. 3. ITS Communication [4].

- Data Processing: The data processing center analyzes information to extract valuable insights and identify trends or irregularities. Data can be processed locally on the device (edge computing) or through centralized servers (cloud computing) [16], [18].
- Data Storage Technologies: Data storage in ITS can be performed locally on a device (edge computing) or through centralized servers (cloud computing). Cloud computing offers the advantage of data availability for quick accessibility.
- Actor-Network Technology: This refers to the set of security applications that provide safety and privacy. The typical network is the Vehicular Ad Hoc Network (VANET) (Fig. 4), which consists of three entities: the vehicle or On-Board Units (OBU), regulatory and certification authorities, and Road-Side Units (RSU) [16], [22].

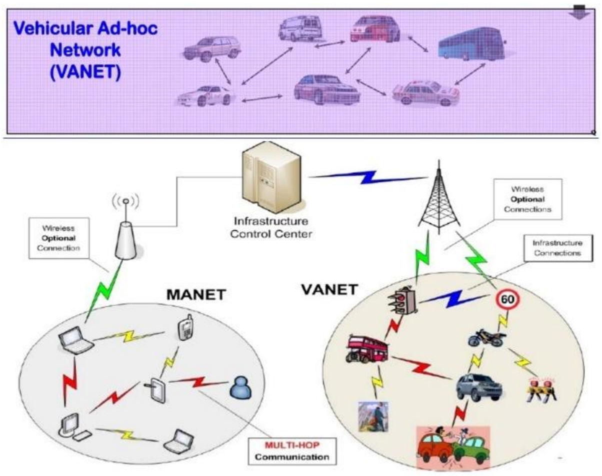

Fig. 4. VANET [23], [24].

2) Functionalities of ITS: ITS encompass several functionalities, the main ones being:

- Traffic Management: Traffic management refers to all measures aimed at maintaining traffic capacity and improving the safety, security, and reliability of the overall road transportation system [25]. These measures include monitoring traffic density through sensors and cameras. Smart traffic lights adapt based on traffic flow, and incident management systems enable rapid response in case of accidents.
- Road Safety: ITS facilitates automatic alerts in case of hazardous conditions (fog, black ice, accidents). Advanced Driver Assistance Systems (ADAS) provide features such as emergency braking, lane-keeping, and adaptive cruise control. The management of pedestrian crossings and sensitive zones is enhanced through ITS [5], [26]– [28].
- User Information System: This is an essential element in the Intelligent Transportation System. It includes mobile applications, dashboards, alert systems, and dynamic information panels that inform drivers and other users about traffic conditions, roadworks, or alternative routes [29]. GPS and connected navigation systems are utilized to guide users [6], [30], [31].

- Intelligent Public Transport: ITS provides real-time travel schedule information through applications, GPS tracking of buses and trains, as well as electronic ticketing systems [32], [33]. These services make public transport easily accessible, reliable, and secure [34], [35].
- Shared and Integrated Mobility: ITS integrates smart parking management features with the detection of available spaces and remote booking options. Integrated mobility services facilitate the combination of multiple modes of transport (car, bicycle, train, etc.) into a single application for seamless management [36], [37].
- Autonomous and Connected Vehicles: ITS has enabled the development of autonomous cars for safer and more efficient transportation [38]. These vehicles are equipped with an autopilot system that allows them to operate without human intervention under real traffic conditions (Fig.5). This automated system functions thanks to various sensors (cameras, lasers, radars) designed to model the environment in three dimensions, thereby identifying road elements such as lane markings, vehicles, traffic signs, pedestrians, and cyclists [38]– [41].

Fig. 5. Autonomous vehicle [39].

IV. APPLICATIONS OF UAVS AND ARTIFICIAL INTELLIGENCE IN SMART TRANSPORTATION

A. Applications of UAVs

UAVs primarily play a role in three areas of application within ITS: the first involves surveillance and data collection, the second is target tracking, and the third pertains to goods delivery [1].

1) Traffic monitoring: UAVs are equipped with various types of sensors, including onboard cameras, to capture large-scale aerial photographs. Their mobility, flexibility, and ability to transmit real-time data make them suitable for traffic data collection [1]. Aerial traffic surveillance is one of the drones' essential tasks. They offer advantages such as a wide field of view, high-speed data transmission, the ability to monitor hard-to-reach areas, and easy deployment [1], [8]. The data collected by drones is of a quality suitable for processing by Machine Learning algorithms [42]. The images collected contain additional useful information, such as geographical coordinates for localization, and video sequences include technical features that facilitate the extraction of relevant traffic information, such as speed and density. Additionally, drone photogrammetry allows for the creation of a highly accurate 3D model of an extended road section. By assembling high-definition images and using geolocation, this method provides a faithful reconstruction of the actual road segment.

2) Tracking: Automatic target tracking in transportation is a feature of professional and military drones. This functionality is based on shape recognition and target localization [10], [43], [44].

- Shape Recognition: With the help of the drone's video feed, tracking is initiated by framing the target in the software. The camera continuously records and, using more or less advanced algorithms, strives to maintain focus on the target. This involves controlling the camera's tilt, as well as the drone's rotation, speed, and altitude [44].
- Target Localization: Drone systems are equipped with GNSS/GPS localization sensors, enabling algorithms to calculate the drone's orientation, altitude, and camera tilt to ensure the target remains within the frame.

The target tracking functionality is utilized in ITS for security purposes. When abnormal behaviors are detected in real-time drone videos, this feature is activated to keep the target within the field of view for a certain period, aiding in investigations [44].

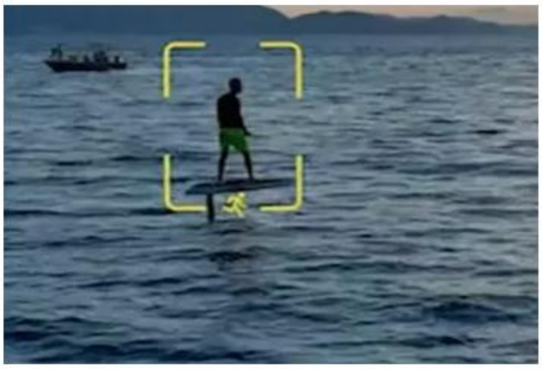

Fig. 6. Tracking by UAV [44]

3) Transport and delivery of goods: Thanks to technological advancements, drones now employ artificial intelligence algorithms to perform programmed or autonomous flights. This enables them to avoid obstacles and create their own routes through the city. This innovative approach to transportation aims to streamline urban traffic and save time. Moreover, it offers undeniable ecological benefits by serving as an alternative to road-based transportation methods. Many companies in the delivery sector are currently working to prepare for the imminent implementation of drone delivery systems.

B. Artificial Intelligence applications in ITS

Machine Learning and Deep Learning techniques have numerous applications across various domains, including transportation (Fig. 7). In Figure 7, it can be observed that certain technologies, such as expert systems, are declining over time, while Deep Learning and Reinforcement Learning are gaining popularity as technological advancements progress. Several Deep Learning and Machine Learning algorithms are employed in various tasks related to intelligent traffic management and road safety [45]. AI applications in transportation can be grouped into three use cases: intelligent transport management, safety enhancement, and comfort services including autonomous driving [11]. The various Machine Learning and Deep Learning tasks, along with the algorithms involved in each category of applications, are listed in Table II, which is not exhaustive.

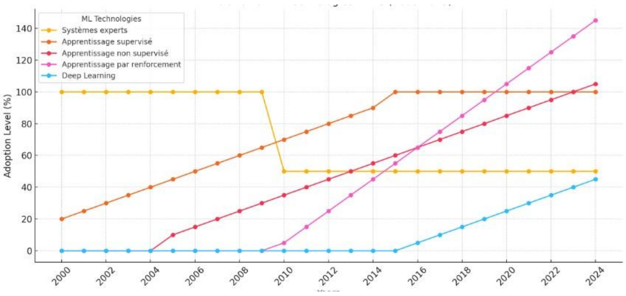

Fig. 7. Evolution of ML technologies in ITS from 2000 to 2025.

TABLE II
OVERVIEW OF AI APPLICATIONS IN ITS [11], [46]– [50]

ITS Applications	AI Tasks	Algorithms
Traffic management	Target detection	YOLO, RCNN, SSD
	Extracting parameters	YOLO, F-RCNN
	Vehicle tracking	YOLO, F-RCNN
	Flow prediction	YOLO, GCN, LSTM
	Speed prediction	YOLO, KNN, SVR
	Time prediction	YOLO, CNN, LSTM
	Congestion prediction	YOLO, CNN, KNN
	Smart traffic lights	SSD, RL, RetinaNet
	Automatic tolling	YOLO, F-RCNN
	Smart Parking	YOLO, F-RCNN
Improving safety	Anomaly detection	YOLO, CNN, SSD
	Traget tracking	YOLO, F-RCNN
	Accident prediction	YOLO, KNN, SVM
Autonomous driving	Remote maintenance	SVM, KNN, MLP
	Geolocation	BNS, RF, RT
	Autonomous driving	BNS, NNR, CNN

1) AI applications in traffic management: Artificial intelligence plays an increasingly important role in traffic management, offering innovative solutions to optimize the flow, safety, and efficiency of road networks. Deep Learning and Machine Learning algorithms significantly contribute to processing traffic data to predict transportation events [51]. These data primarily consist of numerical traffic flow data, images, and videos. The algorithms used in road traffic management tasks mainly include computer vision algorithms (YOLO, CNN, SSD, RetinaNet), Decision Trees (Regression Tree), and Clustering (K-Means). Computer vision algorithms operate on image and video data, while the others process numerical traffic flow data.

- Target Detection: This is performed using Deep Learning algorithms, particularly those in computer vision, such as Faster R-CNN, R-FCN, SSD, RetinaNet, and YOLO. These algorithms are well-suited for vehicle detection, with variations in detection time and accuracy. Two-stage detection algorithms (R-CNN, Fast R-CNN, Faster R-CNN, R-FCN) generally provide better detection accuracy compared to one-stage detection algorithms (YOLO, SSD, RetinaNet). However, the detection speed of one-stage algorithms is significantly superior [2]. Variants of YOLO are commonly used for detecting traffic lanes, vehicles, traffic signs, and pedestrians. [52], [53].
- Extraction and Prediction of Traffic Flow Parameters: AI models are implemented to perform vehicle counting and calculate dynamic traffic flow parameters. The algorithms used include ANN, KNN, SVM, CNN, LSTM, Encoders, GRU, GCN, YOLO, ARIMA, Kalman Filter, and Regression [54]. YOLO enables real-time vehicle tracking and counting [49], while Convolutional Neural Networks (CNN) [55] and Mask-RCNN [56], [57] are used for counting. K-means clustering and SVR [58], [59] are applied for traffic flow prediction. Deep Neural Networks (DNN) and Long Short-Term Memory Neural Networks (LSTM-NN) are utilized to predict vehicle speed [60], [61].
- Congestion Prediction: The goal of congestion prediction is to anticipate the emergence of traffic bottlenecks that could slow down or block a road, considering factors such as traffic volume, road capacity, weather conditions, accidents, and other events. Traffic congestion forecasting aims to estimate congestion conditions at specific locations and times using various statistical and Machine Learning methods. This enables drivers to plan efficient routes and helps traffic management allocate resources appropriately. Congestion prediction is performed using computer vision algorithms (YOLO, CNN) and autoencoder-based Deep Congestion Prediction Networks (DCPN), Deep Neural Networks (DNN), KNN, Fuzzy-RBF, and LSTM [62], [63]. These AI-powered systems alert drivers to congested areas or incidents before they are impacted.
- Smart Traffic Lights: Optimizing traffic flow at intersections is possible through the management of traffic lights, minimizing the time vehicles spend idling. The integration of AI algorithms enables the synchronization of traffic lights using real-time sensor data and leveraging the predictive outcomes of implemented models [11]. This adaptive traffic light management adjusts the signals based on real-time demand. Linear Regression is particularly suited for this approach due to its ability to formulate traffic signal management as a sequential decision-making problem. This traffic light control improves safety and traffic efficiency while minimizing congestion [45].
- Electronic toll collection is a system that allows toll payments to be made remotely via electronic means. It enables road users to pay tolls without stopping at toll collection points, as seen on toll roads, bridges, and tunnels, using license plate recognition technologies. This application helps reduce congestion and costs while enhancing safety and efficiency [11], [64].
- Smart Parking: AI facilitates intelligent parking management by enabling vehicle users to remotely find available parking spaces efficiently and optimize parking space usage [45]. The application of parking space detection algorithms and deep LSTM networks to predict parking availability helps save time spent searching for a parking spot [65].

2) Safety management applications: AI is used to quickly detect accidents, dangerous behaviors, or traffic violations.

Its applications in the field of intelligent transportation cover several aspects of safety, including the safety of people, property, and data exchanged within transportation systems. Algorithms are implemented to detect road anomalies, predict accidents, and track targets.

- Anomaly Detection: Computer vision algorithms analyze traffic image and video data to identify any irregularities or anomalies that may indicate potential events. These can include accident scenes, road degradation [47], [66], abnormal user behaviors, or road obstacles caused by debris or unexpected incidents. Such anomalies are detected using computer vision algorithms (YOLO, CNN), Decision Trees [67], and several other algorithms that have been implemented in scientific research [19], [68]– [75].
- Target Tracking: Target tracking through artificial intelligence is a key technology used in the field of security. It involves four main steps: Target Detection: Based on neural networks such as CNN, YOLO, and Fast R-CNN. Target Tracking: Performed using Kalman filters, particle filters, and visual correlation techniques. Identification and Re-identification: In cases of temporary target loss. Data Updating and Management: This step allows the model to continuously adjust predictions based on new data from sensors. The techniques used for target tracking rely primarily on deep neural network algorithms, particularly those in computer vision, such as YOLO, Fast R-CNN, and DeepSort. [76]– [78].
- Accident Prediction: The application of artificial intelligence (AI) to predict accidents is essential for improving road safety and reducing the human and financial toll associated with accidents. The techniques used include supervised learning algorithms (Logistic Regression, Decision Trees, Random Forest, Gradient Boosting such as XGBoost and LightGBM), unsupervised learning algorithms such as Clustering (K-Means, DBSCAN), and Principal Component Analysis (PCA) [11], [23], [79]. Deep Learning, particularly CNN, and Reinforcement Learning are also used to analyze complex data and mitigate accident risks in real time. These algorithms operate on a wide range of data, including historical accident data, weather data, traffic data, geospatial data, driver behavior, and real-time data from sensors [80].

3) Comfort applications: AI comfort applications in intelligent transportation focus on services such as vehicle telemaintenance, vehicle localization, and autonomous or automatic driving.

- Vehicle Telemaintenance: Vehicle telemaintenance aims to identify confirmed malfunctions or potential issues in various vehicle subsystems (fuel, exhaust, cooling, ignition). Algorithms process data from vehicle sensors to predict or detect failures and send alerts to drivers regarding vehicle maintenance [11]. The algorithms used for this task include Decision Tree, SVM, KNN, MLP, and DNN. This AI application seeks to address problems without requiring the vehicle to be taken to a repair shop. It helps avoid regular interventions by identifying and resolving malfunctions early.
- Vehicle Localization: Vehicle localization relies on sophisticated algorithms capable of accurately locating a vehicle in real time, even in complex scenarios. Various algorithms are used: Deep Neural Networks, Extended Kalman Filters, and Bayesian Networks analyze sensor data to estimate the position. Supervised Learning and Reinforcement Learning are applied to correct drift and inertial noise errors. Other models predict future positions by incorporating the vehicle’s movement history and environmental data [81]– [85].
- Automatic or autonomous driving: Artificial intelligence has facilitated autonomous driving, a significant technological advance in the automotive sector. It relies on intelligent devices (sensors, cameras, Radar, Lidar, GPS) that can detect the environment, make choices in real time and steer the vehicle without the need for human intervention [11]. The six levels of autonomy defined by the Society of Automotive Engineers (SAE) are: level 0 is without autonomy, level 1 with driver assistance, level 2 with partial automation, level 3 with conditional automation, level 4 with high automation and level 5 with full automation, corresponding to the truly autonomous vehicle. To be autonomous, the vehicle system relies on several algorithms: computer vision enables image analysis to identify objects, pedestrians and roads; Reinforcement Learning algorithms enable dynamic decision-making based on simulated trial and error; and Natural Language Processing (NLP) enables voice interaction with the system.

V. DISCUSSIONS

Artificial intelligence and drones are transforming intelligent transportation systems, offering innovative approaches to infrastructure management, control and improvement. The objectives of ITS are to improve safety, optimize management, reduce environmental impact and facilitate mobility. The use of drones and AI contributes to achieving these objectives. The synergy between drones and Artificial Intelligence improves the efficiency of transport systems through optimized traffic and route management. Drones help to improve the collection and transmission of real-time transport data, while AI helps to optimize the operation of intelligent systems. Personal safety is enhanced by real-time traffic monitoring, anomaly detection and event prediction (congestion, accidents). Automated infrastructure inspection using UAVs and algorithms reduces operating costs and optimizes logistics resources. Optimizing routes and reducing congestion helps to cut CO2 emissions and make better use of infrastructure. Early detection of incidents facilitates emergency management, and rapid response reduces economic losses. However, the use of UAVs and AI in transportation systems presents a number of challenges: technological challenges, regulatory challenges, and social and ethical challenges. The accuracy and reliability of sensors and computing power can lead to operational limitations.

Also, the use of drones for surveillance and AI for processing raises concerns about citizens' privacy, the security of collected data and regulations in urban areas.

VI. CONCLUSION

Intelligent Transportation Systems play a leading role in the efficient management of modern transport networks. They rely on cutting-edge technologies to collect, process, and disseminate real-time information. Drones, equipped with advanced sensors and communication capabilities, combined with artificial intelligence and its powerful analytical algorithms, represent two major advancements in the field of ITS. The use of drones and artificial intelligence in intelligent transport systems significantly impacts the safety, efficiency, and sustainability of transport networks. Despite the challenges posed by their use in ITS, their integration enables smoother traffic flow, optimized resource management, and a reduced ecological footprint.

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