Abstract

Various novel innovations and the integration of artificial intelligence (AI) components have significantly reshaped Intelligent Road Transport Systems (IRTS) in recent times. Among different challenges in IRTS, environmental issue, primarily originating from vehicle-emitted pollutants, pose a significant concern nowadays. Utilizing advanced devices like sensors, AI-cameras, and data analytics chips, these advanced systems monitor and evaluate air quality across road networks. Through the incorporation of real-time pollution detection mechanisms into transportation infrastructure, IRTS not only pinpoint pollutant sources but also play a important role in formulating impactful mitigation strategies. These systems empower authorities to swiftly address pollution incidents, enact traffic management interventions, and help to execute proper action in real-time. Through the collaboration of AI and transportation engineering, IRTS enhance our ability to create healthier and more sustainable urban environments by actively combating the adverse effects of pollution on both human health and the ecosystem.

Another important aspect in the revolutionized realm of traffic management is to apply law enforcement through their sophisticated Automatic License Plate Recognition (ALPR) capabilities. By deploying cutting-edge technologies such as machine learning (ML) solutions, and computer vision frameworks, IRTS can efficiently and accurately identify and process license plate information in real-time. This functionality proves invaluable for law enforcement agencies in monitoring traffic, managing parking, and ensuring public safety. The integration of ALPR into IRTS facilitates the automation of many tasks such as toll collection, parking management, handling anti-theft activity etc. This not only streamlines administrative processes but also enhances the overall efficiency and effectiveness of traffic control. The communication between IRTS and ALPR system represents a significant stride towards creating smarter and more secure transportation infrastructures.

In another domain, IRTS are playing a crucial role in handling inside-vehicle safety. These systems leverage advanced technologies such as GPS tracking, sensor deployment, and real-time data analysis to monitor and ensure the security of passengers using various AI-enabled processes. Even during the recent pandemic, IRTS has prompted the exploration of an entirely new research area focused on enhancing passenger life safety. Road transport played a significant role in the spread of COVID-like diseases. Monitoring the number of passengers automatically posed a considerable challenge to restraining such infectious diseases. Traffic agencies had to adapt rules governing passenger counts on roads to ensure a safer distance, providing a secure environment for both drivers and passengers. Amid this pandemic, it became crucial to enforce mandatory checks on mask-wearing status inside vehicles. Manual checking of the same status imposed significant

hurdles. Numerous innovations in this area have profoundly transformed the landscape of IRTS during this crisis period.

While studying several IRTS innovations, object recognition and detection are two important and widely used techniques. Therefore, a nuanced comprehension and precise definition of these terms within the context of IRTS are imperative. Object detection, a facet of computer technology aligned with computer vision and image processing, involves identifying instances of semantic objects belonging to specific classes (such as humans, buildings, or cars) within digital images and videos. Object detection is crucial in IRTS as it enables real-time identification of vehicles, pedestrians, and obstacles, enhancing traffic management and safety. This technology facilitates efficient monitoring and control, optimizes traffic flow, and contributes to the overall effectiveness of IRTS innovations. Conversely, object recognition in the context of AI entails the capacity of AI implementations and systems to identify and categorize diverse entities. Recognition, in the same context, involves the identification of someone or something based on prior encounters or knowledge. The difference between object detection and object recognition becomes apparent in their distinct goals and outputs. Object detection not only involves the identification of objects but also the precise localization through bounding boxes, offering detailed information about their placement. In contrast, object recognition is primarily concerned with the higher-level understanding and categorization of objects within an image, obviating the necessity for precise localization.

The objective of this thesis is to introduce innovative concepts into the IRTS domain with the aim of enhancing system efficiency. The goal is to establish robust surveillance systems within road transport to provide a risk-free road environment. Implementing continuous automated monitoring and executing responsive actions significantly alleviates human effort as well. This represents an additional objective of the research endeavor. Another integral goal of the thesis is to automatically monitor on-road vehicle pollution and implement necessary measures, contributing to a pollution-free and eco-friendly environment. Ultimately, the thesis is determined by its commitment to ensure a safer road environment for all, aligning seamlessly with the objectives of smart transport.