APPLICATION OF COMPUTER VISION FOR SAFER AND MORE EFFICIENT URBAN ENVIRONMENTS

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Introduction. The rapid growth of urban populations and the increasing complexity of city infrastructure demand innovative solutions to enhance urban living and ensure public safety. Computer vision technologies based on convolutional neural networks (CNNs) are becoming one of the key technologies for building smart cities, providing real-time automatic analysis of urban environments. Unlike traditional video surveillance systems, intelligent object recognition systems are capable of not only recording what is happening, but also automatically interpreting visual data, which opens new opportunities for optimizing urban processes and making timely management decisions. By utilizing CNNs for object recognition and analysis, such systems can automatically identify vehicles, pedestrians, and other objects, assisting in maintaining public safety, managing traffic flow, and improving urban infrastructure. Ultimately, this leads to safer and more livable cities.

Objectives. The purpose of this work is to analyze the application of computer vision technologies based on convolutional neural networks (CNNs) to enhance public safety and optimize urban infrastructure in the context of smart cities.

Methods. To achieve this objective, methods of analysis and information systematization were applied to explore computer vision technologies used in smart cities. A systematic review of scientific literature and practical case studies on the use of object recognition technologies within urban settings was conducted. The analysis covered both social and technical aspects of implementing such systems, as well as their impact on public safety and quality of life.

Results. The integration of computer vision technologies into smart city infrastructures offers significant opportunities for enhancing public safety, optimizing traffic flow, and improving quality of life for city residents. Systems based on convolutional neural networks (CNNs) can automatically detect and classify various objects in urban environments – such as vehicles, pedestrians, and obstacles, enabling quick and effective responses to real-time events.

One of the primary applications of computer vision is traffic monitoring. Surveillance systems equipped with object recognition capabilities can detect traffic violations, identify congestion, and analyze traffic density, contributing to more effective traffic management and reducing the risk of accidents. For instance, the study by Jaramillo-Alcazar et al. (2023) demonstrated that real-time data processing from surveillance cameras and traffic lights using AI algorithms reduced peak-hour congestion by 20%.

Computer vision is also used to ensure public safety. Video surveillance systems with facial recognition and behavior analysis capabilities can detect suspicious activities, help prevent crimes, and enable timely responses from security services. For example, in the United Kingdom, AI-equipped cameras were tested to analyze passengers' emotions at railway stations to explore potential applications for public safety monitoring (Burgess, 2024). Additionally, comprehensive surveillance systems using anomaly detection methods can identify potential risks, such as concealed weapons, unusual behavior, and crowd formations, significantly strengthening crime prevention and monitoring capabilities (Myagmar-Ochir & Kim, 2023).

In emergency response, computer vision systems can automatically detect fires, gas leaks, or flooding, allowing for immediate alerts to relevant services and minimizing potential damage. One example of such technology is a hybrid model that combines Local Binary Patterns (LBP) and CNN with YOLOv5 for detecting fire and smoke under various environmental conditions (Dalal et al., 2024).

In urban planning, computer vision technologies are employed to analyze and interpret large volumes of visual data, assisting with the design and management of urban spaces. Semantic segmentation methods can classify different urban elements in images, providing planners with data on city composition and land use. A study titled “Semantic Segmentation for Urban-Scene Images” discusses the application of deep learning models, such as Fully Convolutional Networks (FCNs), in segmenting urban scenes to identify components like buildings, roads, and plants, which is crucial for urban planning and development (Sharma, 2021).

Additionally, computer vision is also applied to evaluate visual quality and the aesthetic appeal of urban areas. By analyzing street-level images, these systems can assess factors like greenery, building conditions, and cleanliness, which are critical for urban livability and attractiveness. The paper “FaceLift: A Transparent Deep Learning Framework to Beautify Urban Scenes” presents a framework that not only predicts the perceived beauty of urban scenes but also suggests modifications to enhance their aesthetic appeal, demonstrating the role of computer vision in urban aesthetics assessment (Joglekar et al., 2020).

Conclusion. The application of computer vision technologies in urban infrastructure maintenance and planning provides significant advantages in efficiency, accuracy, and proactive management. By enabling real-time monitoring, automated object detection, and advanced data analysis, these systems enhance public safety, optimize traffic flow, and support informed urban planning decisions. As these technologies continue to evolve, they hold the potential to transform urban environments into “smarter”, more sustainable, and adaptable spaces.

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