

ePAM: Advancing Sustainable Mobility through Digital Parking, AI-Driven Vehicle Recognition, and CO₂ Reporting

Authors : Robert Monsberger

Abstract : The increasing scarcity of resources and the pressing challenge of climate change demand transformative technological, economic, and societal approaches. In alignment with the European Green Deal's goal to achieve net-zero greenhouse gas emissions by 2050, this paper presents the development and implementation of an electronic parking and mobility system (ePAM). This system offers a distinct, integrated solution aimed at promoting climate-positive mobility, reducing individual vehicle use, and advancing the digital transformation of off-street parking. The core objectives include the accurate recognition of electric vehicles and occupant counts using advanced camera-based systems, achieving a very high accuracy. This capability enables the dynamic categorization and classification of vehicles to provide fair and automated tariff adjustments. The study also seeks to replace physical barriers with virtual 'digital gates' using augmented reality, significantly improving user acceptance as shown in studies conducted. The system is designed to operate as an end-to-end software solution, enabling a fully digital and paperless parking management system by leveraging license plate recognition (LPR) and metadata processing. By eliminating physical infrastructure like gates and terminals, the system significantly reduces resource consumption, maintenance complexity, and operational costs while enhancing energy efficiency. The platform also integrates CO₂ reporting tools to support compliance with upcoming EU emission trading schemes and to incentivize eco-friendly transportation behaviors. By fostering the adoption of electric vehicles and ride-sharing models, the system contributes to the optimization of traffic flows and the minimization of search traffic in urban centers. The platform's open data interfaces enable seamless integration into multimodal transport systems, facilitating a transition from individual to public transportation modes. This study emphasizes sustainability, data privacy, and compliance with the AI Act, aiming to achieve a market share of at least 4.5% in the DACH region by 2030. ePAM sets a benchmark for innovative mobility solutions, driving significant progress toward climate-neutral urban mobility.

Keywords : sustainable mobility, digital parking, AI-driven vehicle recognition, license plate recognition, virtual gates, multimodal transport integration

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