Camera based Car-Detection and -Tracking for Urban Parking Areas

Students

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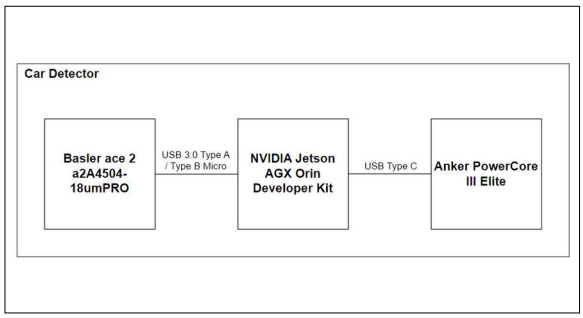
Initial Situation: Urban planners increasingly take measurements of traffic volumes into account in their studies. Manual counts are cost-intensive and should be automated. In this work, the feasibility of camera-based automatic counting of cars at parking lot entrances and exits is to be investigated. The arrival and departure times as well as the dwell time of the vehicles in the parking lot are to be measured.

Objective: This work aims to realize a battery-powered embedded device that is able to recognize and track individual cars. Separately trained deep neural networks are used to recognize cars and their license plates. The license plate number must be detected via OCR. Instead of transmitting or storing the license plate number in plain text, a hash is to be calculated and transmitted. This enables an arrival and departure log while complying with data protection regulations. The key challenge is 30 hours of battery operation while visually monitoring the parking lot with a detection rate of better than 80% during day and night.

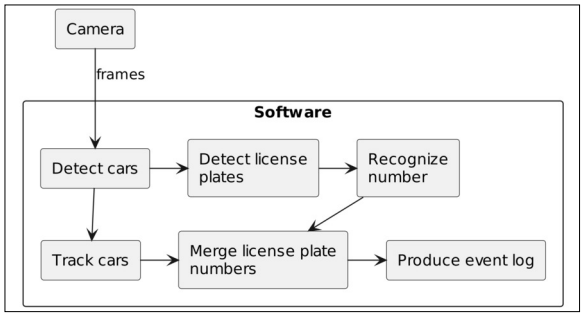
Result: The result is a prototype consisting of an NVIDIA Jetson AGX Orin Developer Kit as the computing unit, a high-resolution grayscale camera from Basler, and a high-performance lens from KOWA. The system is powered via USB from a power bank. All components sit in a specially designed casing for easy installation utilizing off-the-shelf and 3D-printed parts. The software, written in Python, uses state-of-the-art YOLOv8 pre-trained and self-trained object detection models for car and license plate detection, as well as OCR. To improve OCR accuracy of the license plate strings, an algorithm that merges from all available frames similar to majority voting was implemented. The final strings are SHA-256 encoded and written into an event log CSV file.

After several tests, we were able to achieve a recognition rate of around 91% during the day and roughly 61% at night. Performance and power optimizations as well as improving the detection rate in low light conditions are left for future work.

Hardware
Own presentment



Software
Own presentment



Implementation
Own presentment

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Subject Area
Image Processing and Computer Vision, Artificial Intelligence

Project Partner
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