A Simulated Car-Park Environment for the Evaluation of Video-Based On-Site Parking Guidance Systems

Marc Tschentscher, Ben Pruß, and Daniela Horn
University of Bochum, Institute for Neural Computation, Germany

Motivation

- Development of image-processing algorithms requires huge amount of data
- Internet offers numerous tagged images for training and evaluation of classifiers for a number of standard problems
- But: For a more distinct problem it is extremely difficult to find representative images

→ Simulated environment can overcome these problems by creating video data reproducing natural scenes

Simulated Environment

- Based on next-gen graphics engine Unreal Engine 4
- Replica of existing car park for direct comparison to real-world
- Goal: Real-time classification of vacant/occupied parking spaces
- Extraction of ground truth data on the fly
- PBR approach for highly realistic materials
- Implementation of 5 different weather/lighting conditions: sunny, cloudy, foggy, rain, and snow

Material layers used in PBR approach

Artificial Camera

- Generation of highly realistic camera images
- Translation of physical restrictions to virtual camera, such as depth of field, image noise, and motion blur
- Camera model modifies image generation process in UE4
- Model based on parameters of real-world modern camera systems
- Implemented parameters: focal length, aperture opening, film speed, exposure time, and focal distance

Experiments

- Evaluation of classifier previously trained on real-world samples of sunny and cloudy weather images
- Reproduction of real-world video material in simulated environment for direct comparison of classifier performance
- Evaluation of classifier on sequences of different weather and lighting conditions to test its robustness

Software framework YAF; used for image processing. Left: Artificial camera image with lens undistortion applied, Right: Visualization of classification results

Results

- Comparable results for real-world video data and reconstruction
- Difficulties with untrained weather conditions due to underfitting
- Precipitation is challenging task
- Overall good performance on different weather conditions

Outlook

- Train a classifier on a mixture of real-world and artificial video data, or purely on artificial images
- Use the resulting classifier in real-world scenarios
→ Enabling more topics for image-processing algorithms