

Video-based Trailer Detection and Articulation Estimation

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Motivation

- Trailer handling is cumbersome and dangerous
- Assistance systems require particular hardware

Technical approach

- Use of a rear-end fisheye camera
- Obligation for rear-view cameras in new-built vehicles is currently under discussion in the US
- Trailer detection: Decide if a trailer is attached to the hitch
- Trailer articulation estimation: Measure the trailer's articulation angle w. r. t. the vehicle's rear end

Trailer Detection

- Consider a surrounding of the hitch to decide trailer's presence in the image
- Train a set of prototype image sections that describe an empty hitch
- Clustering is performed by complete linkage with normalized cross-correlation (NCC) as distance measure
- Compare current example to closest cluster center as a presence measure



Representation of empty hitch by averaged training examples from each cluster

Trailer Articulation

- No assumptions about trailer model
- Handle strong shadows by relative intensity evaluation
- Local symmetry measure on polar coordinates to identify the drawbar
- Maximum p -quantile of columnwise symmetry distribution yields an articulation angle estimate



Parameter Optimization

Optimize (via grid search)

- the number of clusters and the NCC threshold (Trailer Detection)
- the p -quantile of the columnwise symmetry distribution (Trailer Articulation)
- the extension of the image section showing the drawbar (Trailer Articulation)
- parameters for temporal smoothing

Processing Pipeline



Hitch surrounding after perspective polar transform



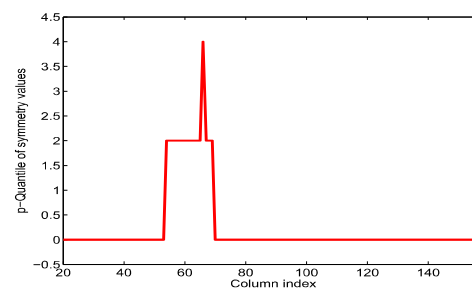
Median-smoothed



Logarithm for intensity difference



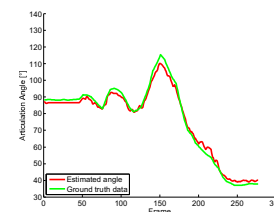
Linewise symmetry



Likelihood measure of trailer w. r. t. articulation angle

Results & Outlook

- TP rate; 95.0% (trailer attached)
- TN rate: 99.5% (no trailer)
- Average articulation angle deviates by less than 2 degrees
- Maximum error at 5 – 7 degrees is still too high for safety applications
- Future work: Handle strong deviations by tracking of several trailer articulation hypotheses at the same time



	#Frames	Scenario	Avg. Est. error [°] (max. error)
TEST A	277	slow manoeuvring	2.19 ± 1.19 (5.48)
TEST B	977	countryside driving	1.69 ± 1.38 (7.55)
TEST C (*)	826	slow manoeuvring	1.97 ± 1.64 (5.78)

* GT angles taken with mechanical measurement unit