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KSOP
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VISIBILITY ASSESSMENT FOR DRIVER ASSISTANCE SYSTEMS

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Motivation: Present vision based driver assistance systems are designed to perform under good-natured weather conditions. However, limited visibility caused by heavy rain or fog strongly affects vision systems and leads to reduced functionality of DAS. To improve machine vision in bad weather situations, a reliable detection system is necessary as a ground base. Furthermore, weather classification and categorization itself forms valuable driver assistance.

Classification of Weather Situations on Single Color Images
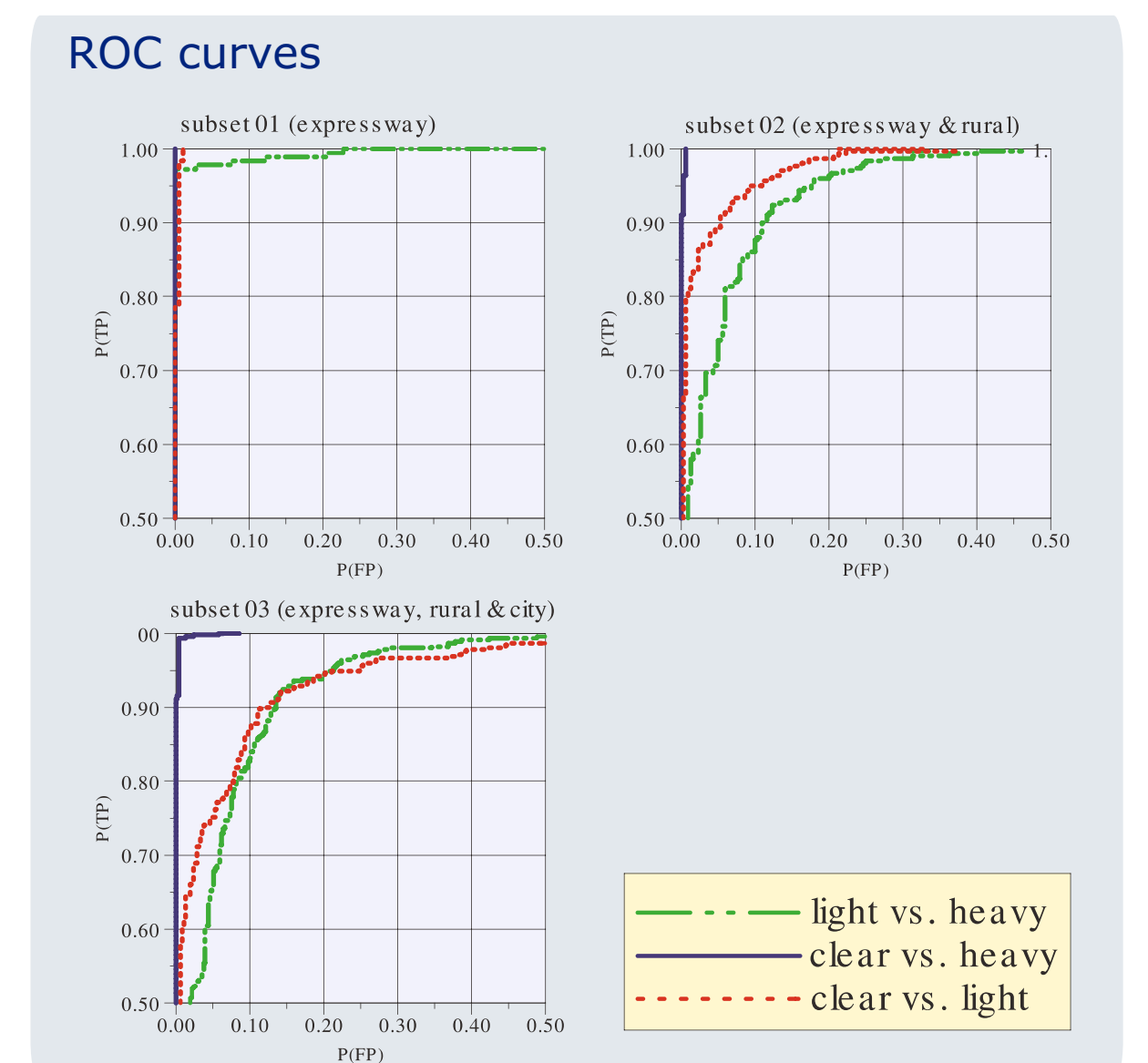
Approach:

☐ Extraction of robust histogram features from global and local regions of interest (ROI)
☐ SVM classification, C={clear, light rain, heavy rain}
☐ Scenarios with increasing demands on classification

flowchart of proposed approach

$$\mathbf{v} = [v_1 \quad \cdots \quad v_n]$$

extended descriptor vector

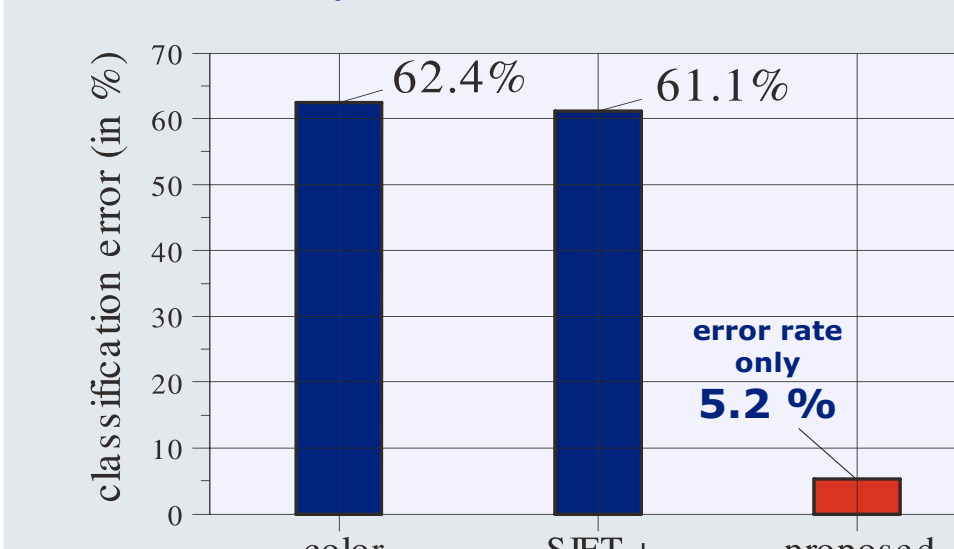SVM → Clear / Light rain / Heavy rain

database examples
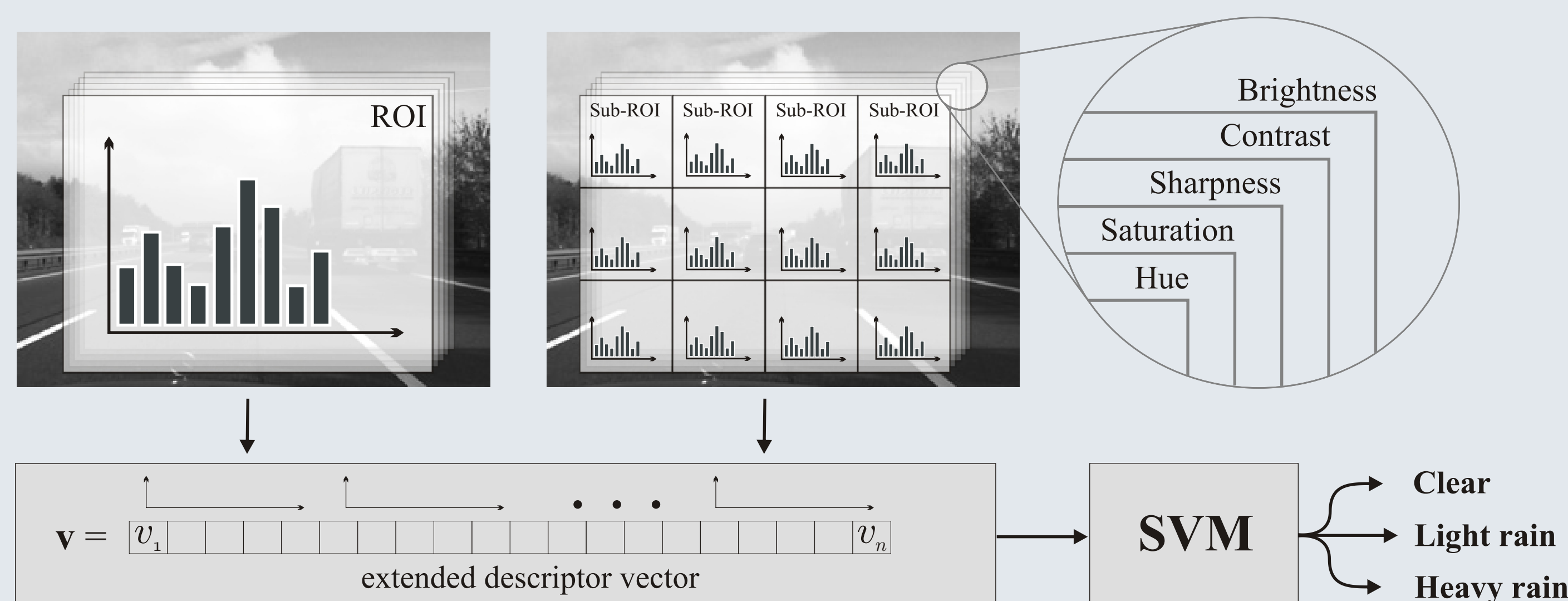
Results:

☐ Low error rates
☐ Misclassifications in situations that are hard to define (even for humans)
☐ Repeated measurements on subsequent images may reduce error rate
☐ Proposed features outperform standard feature descriptors

ROC curves

subset 01 (expressway)
subset 02 (expressway & rural)
subset 03 (expressway, rural & city)

light vs. heavy
clear vs. heavy
clear vs. light

feature comparison

	color wavelets	SIFT + color histogram	proposed features
classification error (in %)	62.4%	61.1%	error rate only 5.2 %

classification results

	expressway scenes			expressway scenes rural street			expressway scenes rural streets urban traffic		
	clear	light rain	heavy rain	clear	light rain	heavy rain	clear	light rain	heavy rain
☀	178	2	0	275	24	1	411	39	0
☁	2	178	0	17	253	30	67	341	42
🌧	0	7	173	0	24	276	5	47	398

Images/class: 180
Error: 2.04%

Images/class: 300
Error: 10.67%

Images/class: 450
Error: 14.81%
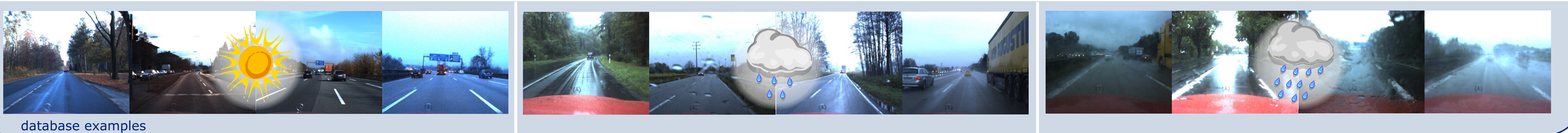
Detection of Raindrops on windshields

Approach:

☐ Creation of a geometric-photometric raindrop model
☐ Prediction of environmental area, seen in the raindrop
☐ Correlation coefficient to verify/falsify raindrop candidate

→ low correlation due to limited camera resolution and blurring (out of focus)
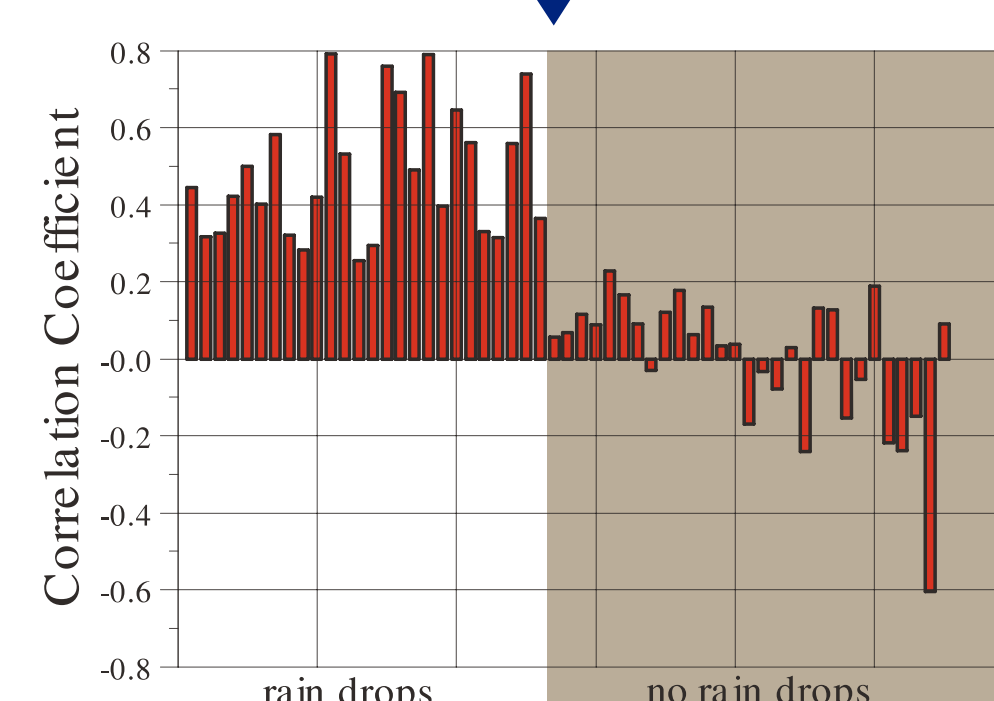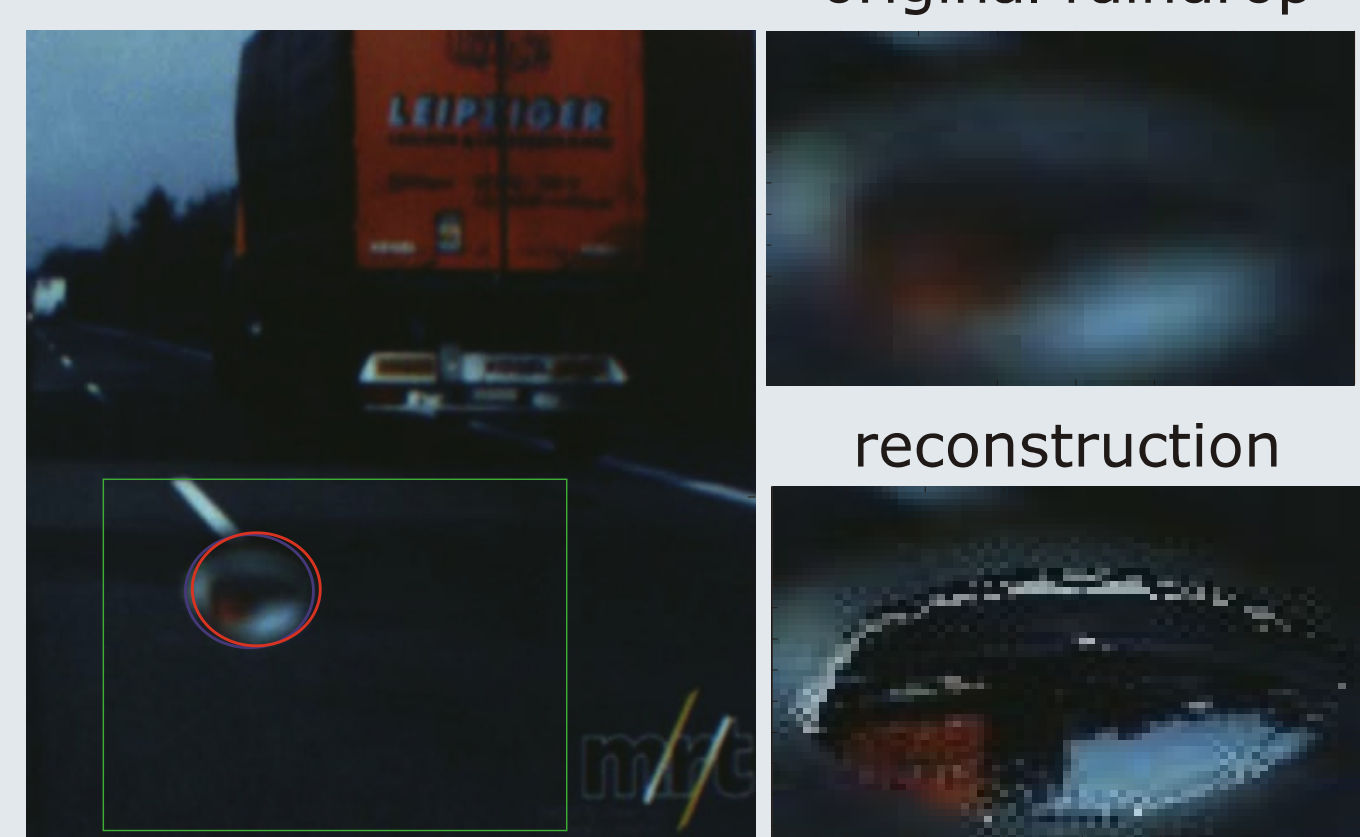
→ nevertheless, appropriate distinction can be drawn

photometric raindrop model

raindrop scanning
raindrop
windshield
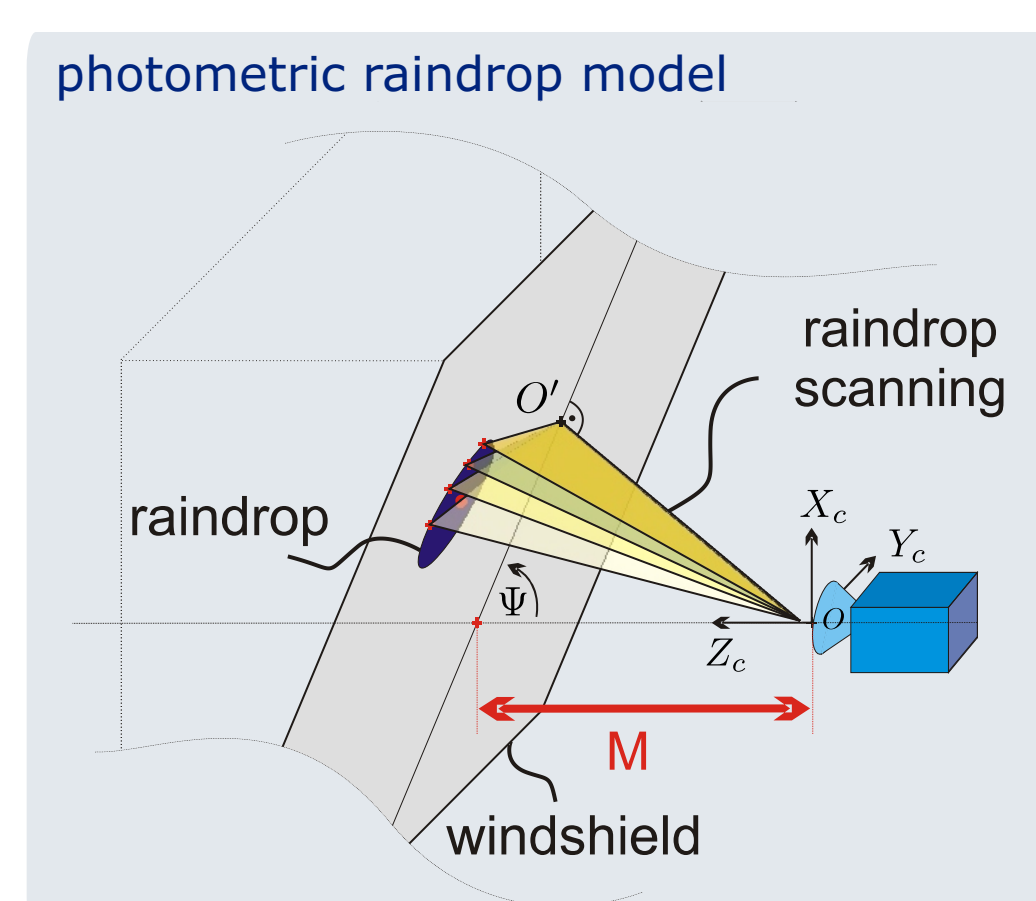
correlation coefficient
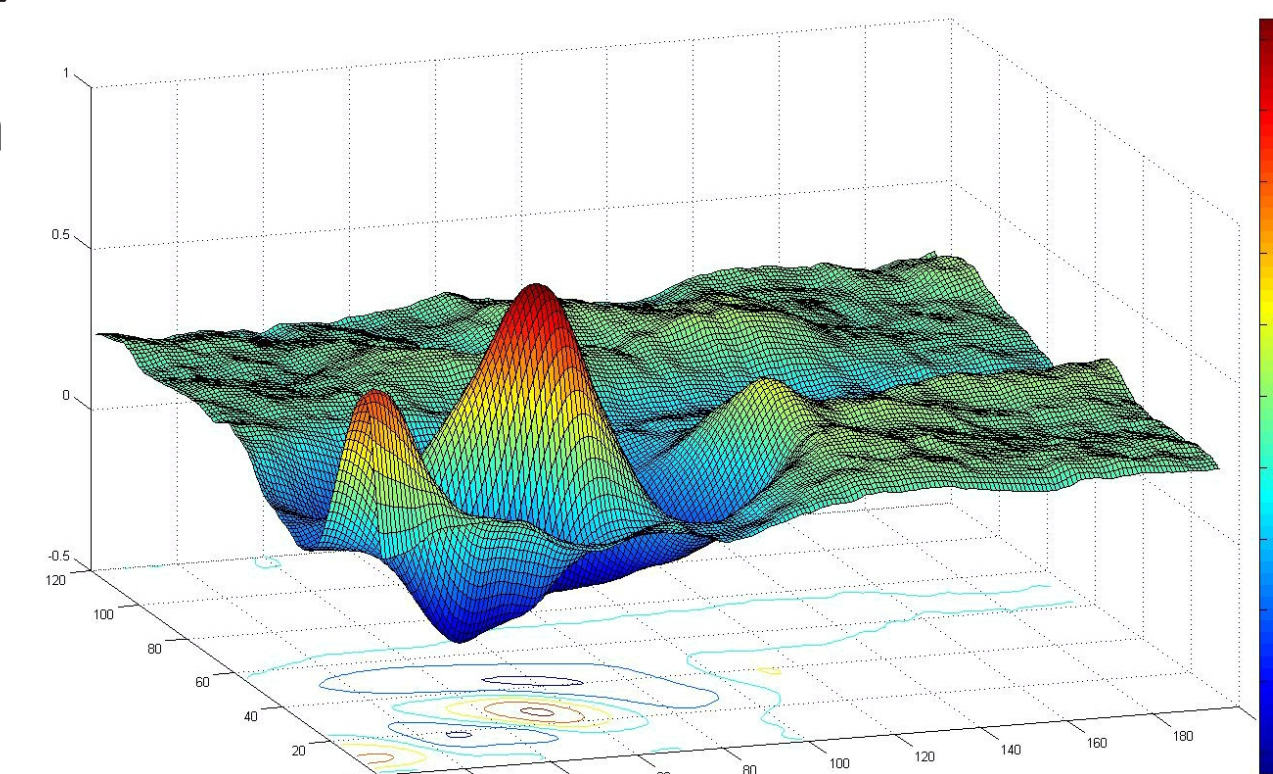
Results:

raindrop reconstruction
original raindrop
reconstruction

rain drops | no rain drops
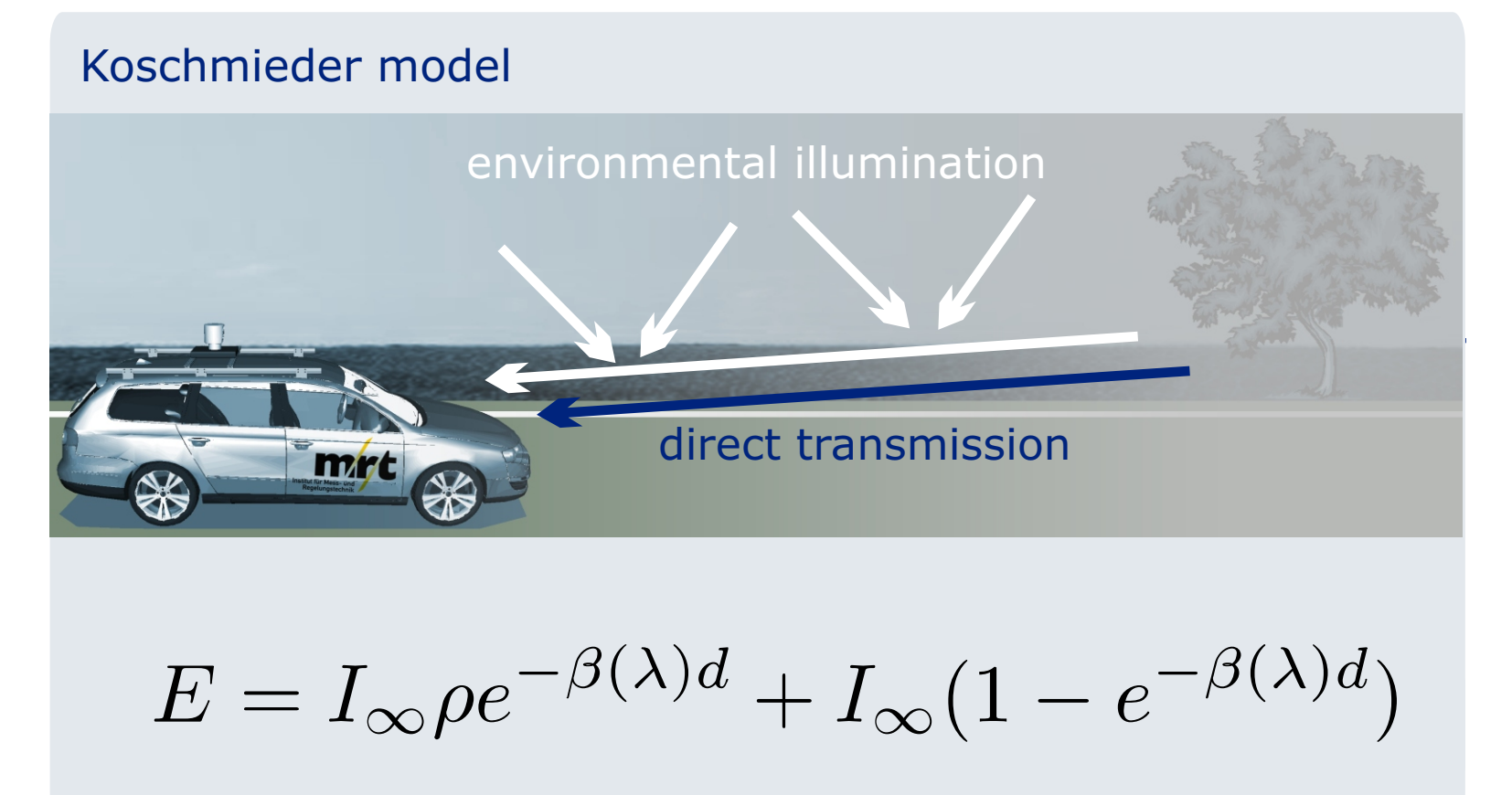Correlation Coefficient

Visibility Estimation

Approach:

☐ Contrast degradation according to Koschmieder model

☐ Measurement of contrast for different distances

☐ Estimation of visibility distance (where contrast drops below c<0.1)

Koschmieder model

environmental illumination
direct transmission

$$E = I_\infty \rho e^{-\beta(\lambda)d} + I_\infty(1 - e^{-\beta(\lambda)d})$$

Results:

Visibility ~ 600m
Visibility ~ 300m
Visibility ~ 200m
C=0.1

The cooperation of Forschungszentrum Karlsruhe GmbH and Universität Karlsruhe (TH)

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