# Robust Adaptive Classifier Grids for Object Detection from Static Cameras*

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Abstract We introduce classifier grids in order to develop an adaptive but still robust real-time object detector for static cameras. We propose to train a separate classifier for each image location, obtaining a specific object detector. For each classifier corresponding to one grid element we estimate two generative representations in parallel, one describing the object's class and one describing the background. These are combined in order to obtain a discriminative model. The on-line learned classifiers enable our system to be adaptive to changing environments. To ensure a stable system, which is needed for continuously learning, we keep the object representation fixed while only the representation of the background is updated.
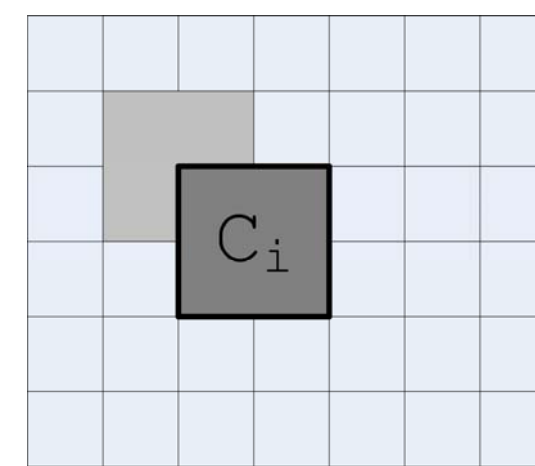
Motivation
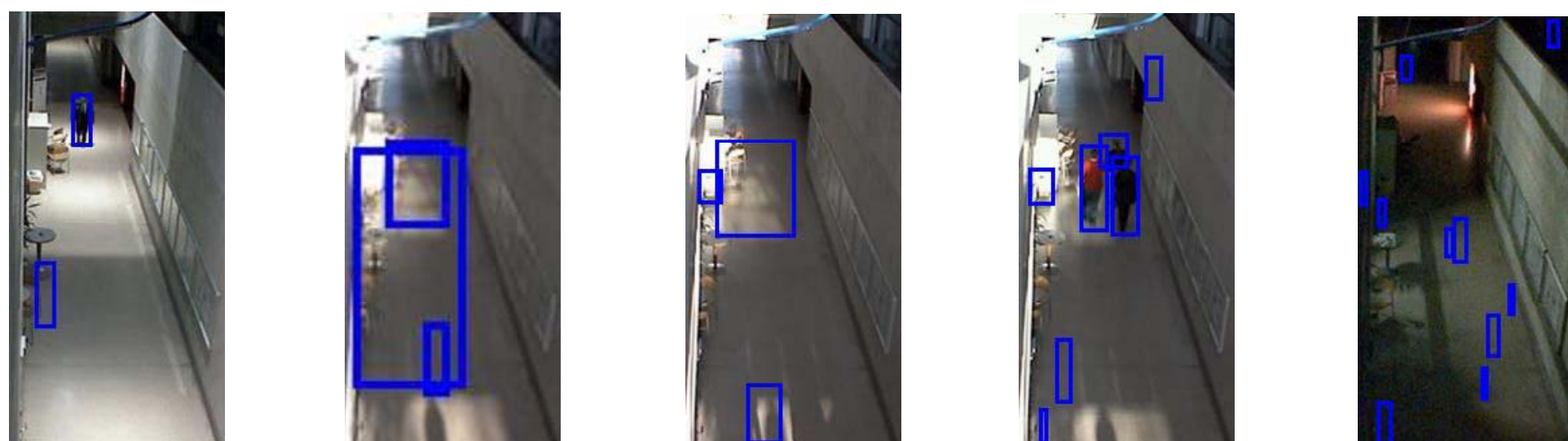
Generic object detector – large number of false positives

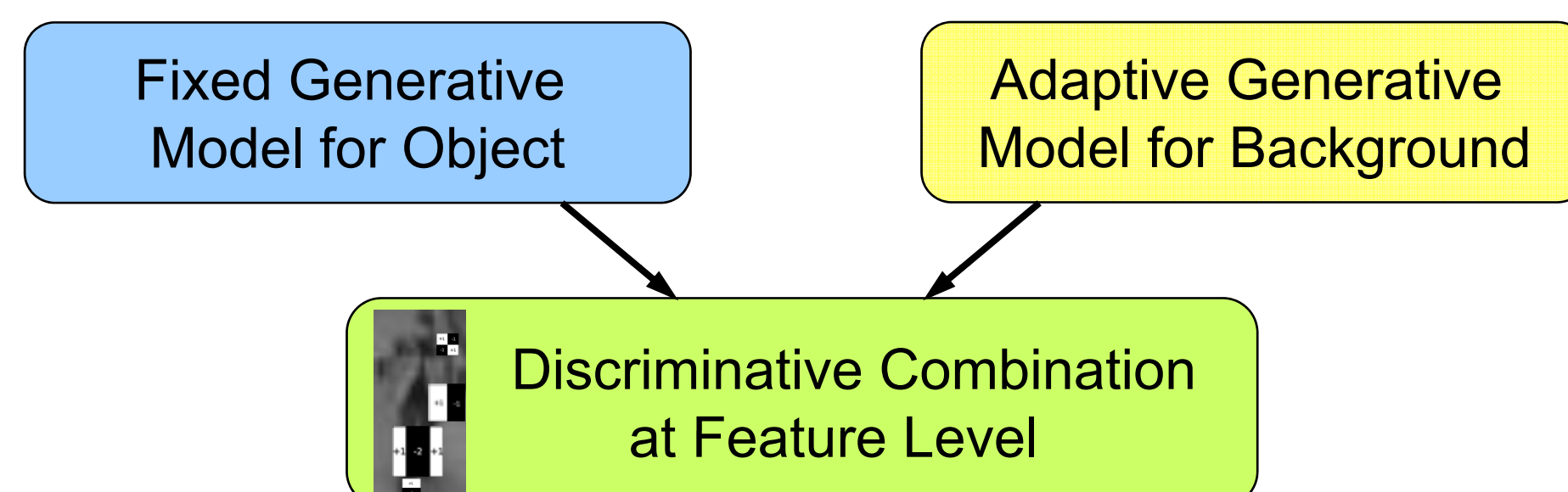Adaptive object detector – able to deal with environmental changes

Classifier Grid

- Sample image by fixed higly overlapping grid
- Each grid element i has own classifier C_i
- Less complex classifiers due to simplification
- Scene calibration to reduce search space

Adaptive systems

- Able to deal with changing environments
- Main problem of adaptive systems: **drifting**
- Avoid drifting by using fixed update rules [2]
  - **Positive updates:** hand-labeled set, correct by definition
  - **Negative updates:** low probability of wrong negative update
  $$P(x_i = \text{object}) = \frac{\# p_i}{\Delta t}$$

Robust Adaptive Grid-based Detector [1]

Fixed Generative Model for Object

Adaptive Generative Model for Background

Discriminative Combination at Feature Level

- **Off-line pre-training**
  Appearance of object stays the same → off-line pre-calculated

- **On-line weak classifier update**
  On-line adaption necessary due to background changes

- **On-line feature selection**
  Features are selected depending on off-line and on-line error

D_j^+ fixed

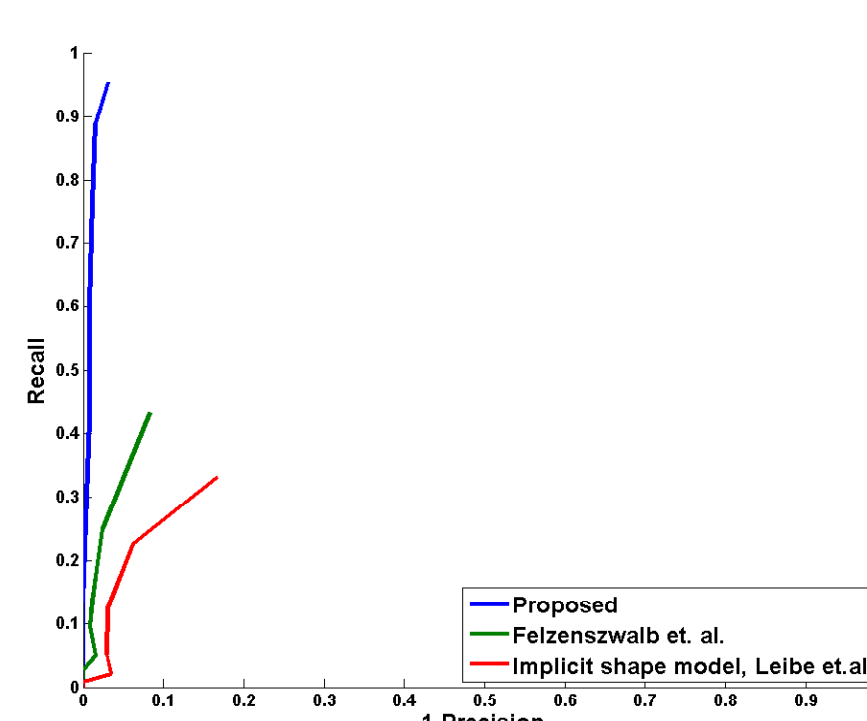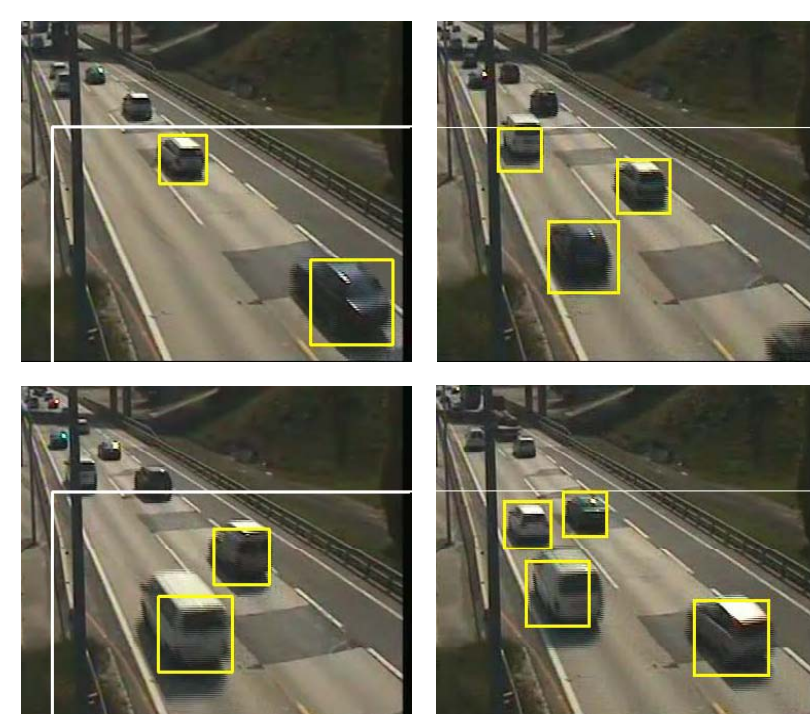discriminative threshold

D_j^- variable

$f_j(x)$
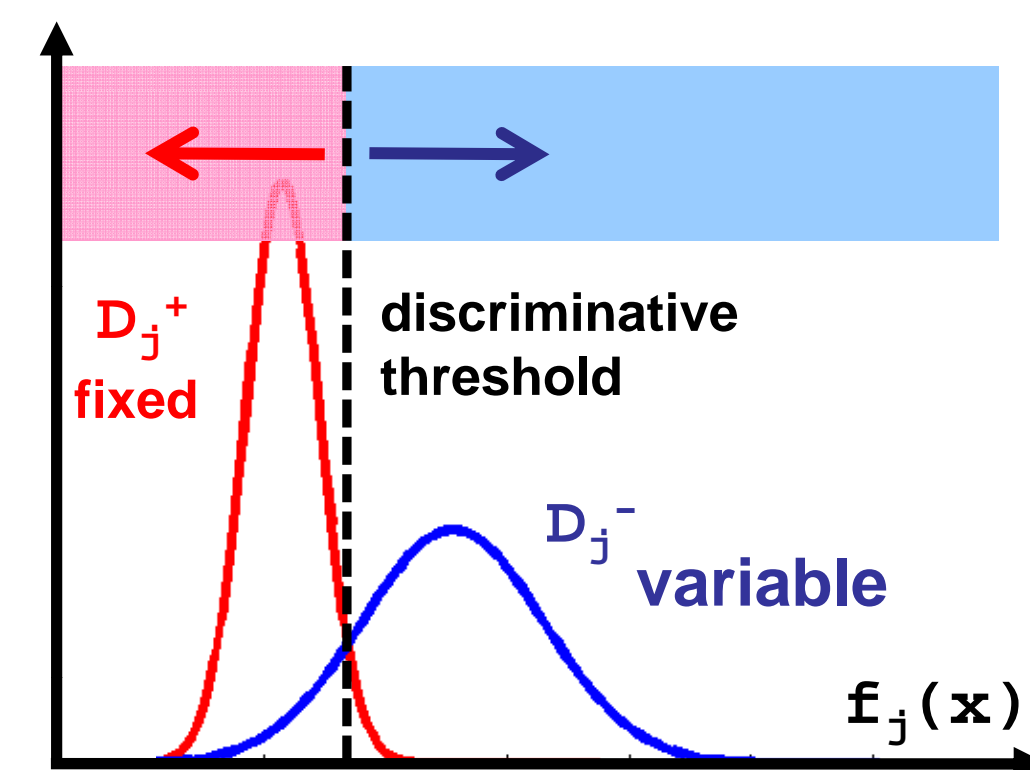
The combination of the fixed generative model describing the object and the adaptive generative model describing the background is located at the weak classifier level.
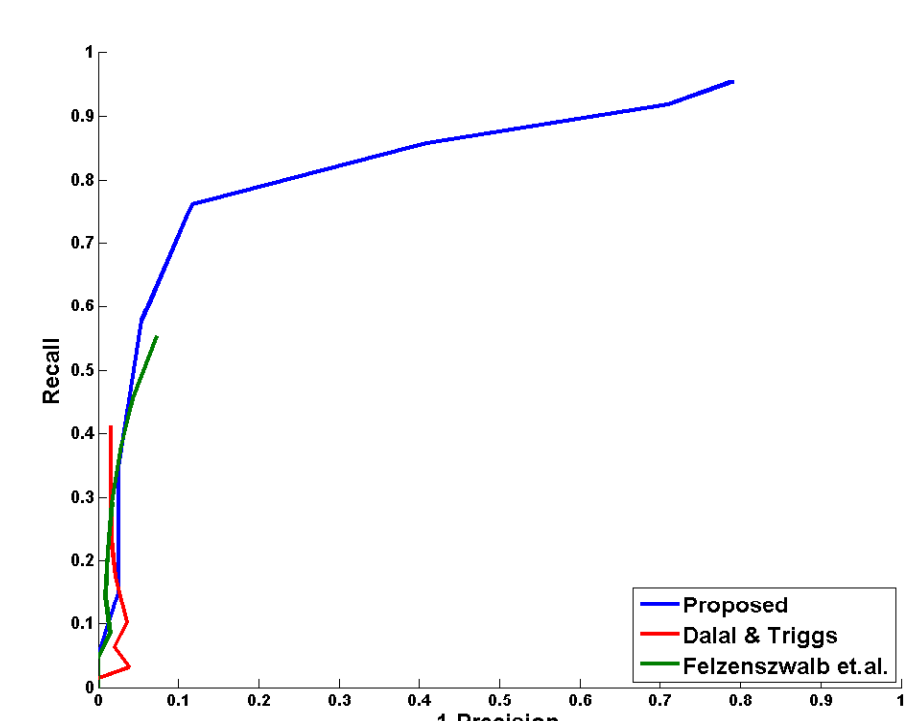
Experiments for Robust, Adaptive and Real-time Object Detection!
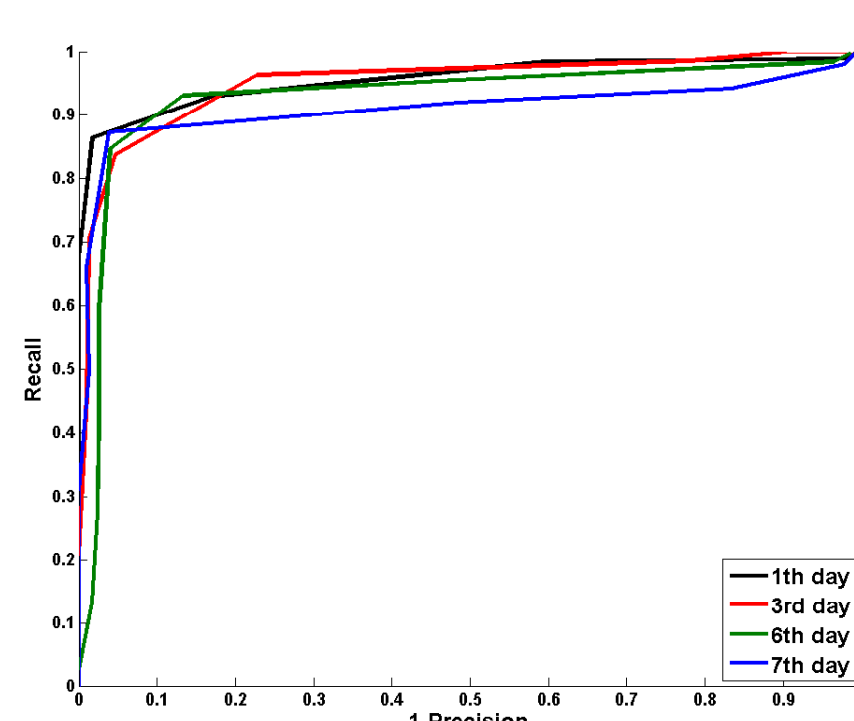
Corridor sequence - 7 days
580.000 updates, no drifting!

Car detection on highways
1.000 frames, compared to SOTA approaches

Publicly available caviar sequence
370 frames, compared to SOTA approaches

References
1. P. Roth, S. Sternig, H. Grabner, H. Bischof, *Classifier Grids for Robust Adaptive Object Detection*, CVPR'09
2. H. Grabner, P. Roth, H. Bischof, *Is pedestrian detection really a hard task?* PETS'07