Doctoral Consortium:

Optimal Object Categorization Under Application Specific Conditions

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Stage of the research

Main focus of the PhD

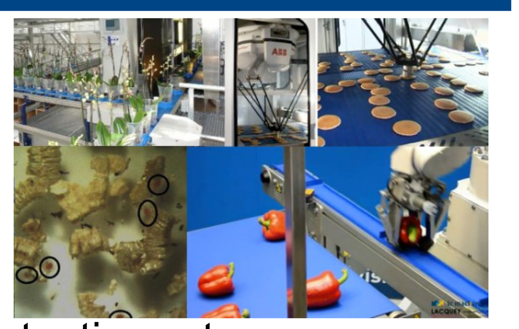
- Universal object categorization framework
- Use application specific scene and object variation
- Reach very high detection rates up to 99,9%

Current progress

- Analyzing state-of-the-art algorithms
- Use of scene and object variation in pre- and postprocessing steps
- Selection of **backbone** algorithm of framework → Dollár ChnFtrs framework

Research problem

Industrial applications



- High intra class variability (size, color, texture, ...)
- Eg. robot picking, object counting, product inspection, ...
- ´In the wild´ ~ 85% detection → not enough

However

- Exploiting application specific constraints can increase detection rate
- Lead to smarter & better object categorization techniques
- Focus on known parameters like camera position, lighting conditions, ...

State of the art

ChnFtrs framework of Dollàr

- Based on integral channel features
- Combination of multiple feature sources + boosting process
- Higher detection rate + less false positives

Backbone for many techniques

- In the wild pedestrian detection (Benenson et al., 2012)
- Optimal trafic sign detection (Mathias et al., 2013)
- Basically integrate extra knowledge through extra feature channels

Assure better and more effective training phase

- Using an active learning strategy → search for effective training samples
- Also a hot and active research topic (Li and Guo, 2013)

Outline of objectives

During the PhD we will focus on three objectives, in order to create a single universal semi – automatic object categorization framework.

1. A high detection rate of 99,9% or higher

- Demand of industrial partners, where classic techniques still fail
- By integrating all extra application specific knowledge

2. A minimal input during the training of an object model

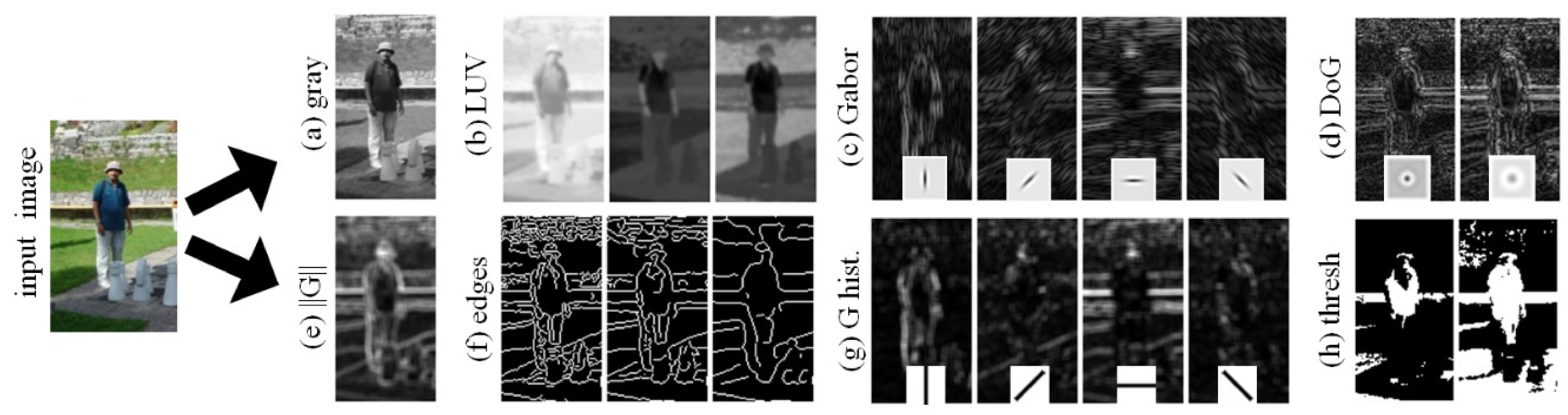
- Classic techniques use thousands of positive and negative samples
- Use knowledge to select interesting training images
- Iteratively annotating and training images

3. A faster and more optimized algorithm

- More functionality like new channels = more processing time
- CPU & GPU optimalizations for real time processing

Methodology

Integration of scene and object variation



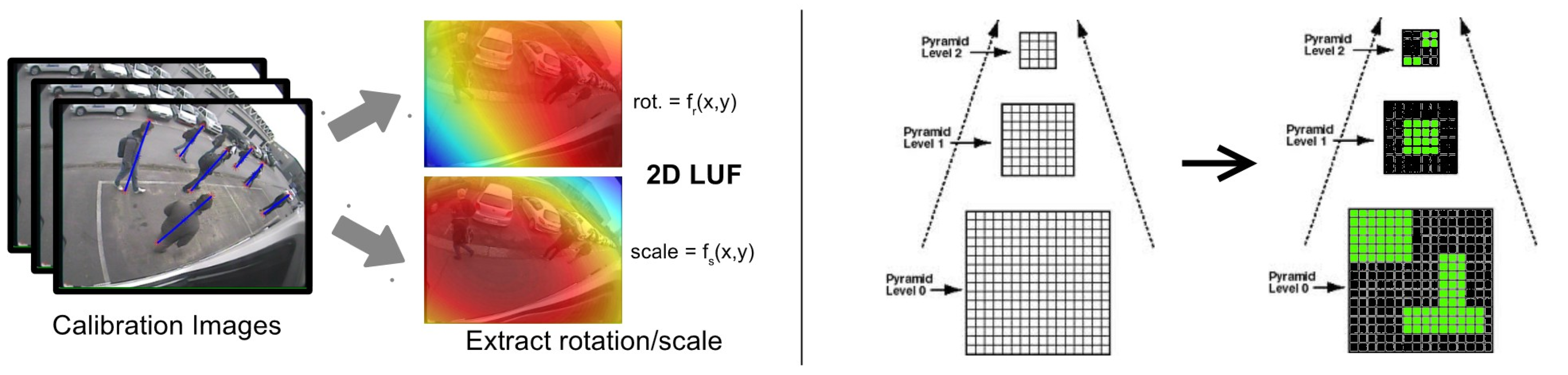
As much channels as possible

- Eg. channels used by Dollár ChnFtrs framework
- Giant pool of features, possible to expand when needed
- Boosting will select the usefull features for the application

Focussing on four feature pools specific to our applications

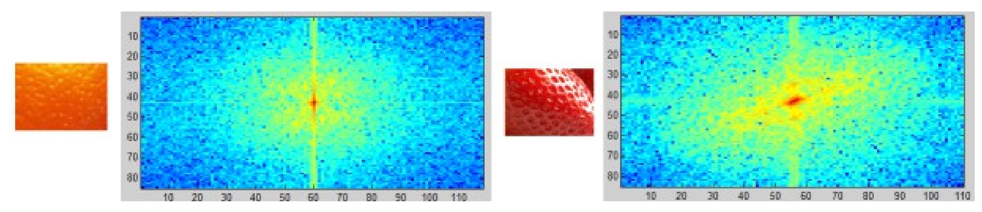
- Influence of object scale and position
- Influence of lighting, color and texture
- Influence of background clutter and occlusion
- Influence of rotation and orientation

Calibrating location into a 2D lookup function + using a segmented scale-space pyramid



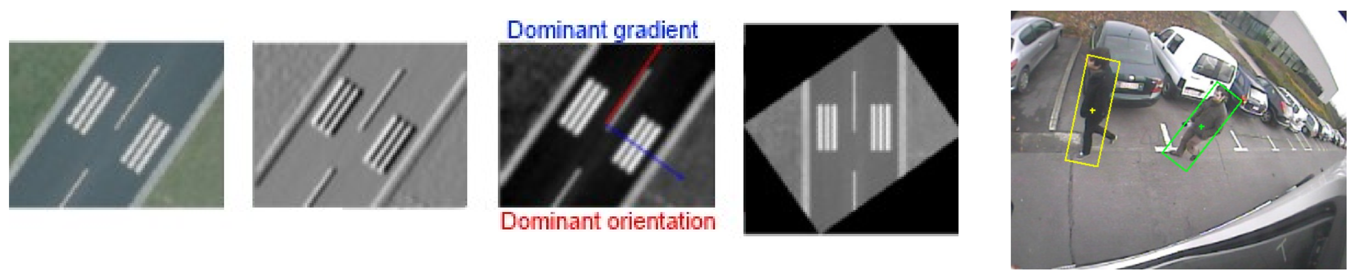
Use of color and texture information to retrieve object specific information

- Use of Fourier frequency spectrum
- Retrieve reoccuring texture to identify an object compared to the background information



Examples of background clutter and occlusion that influence the scene

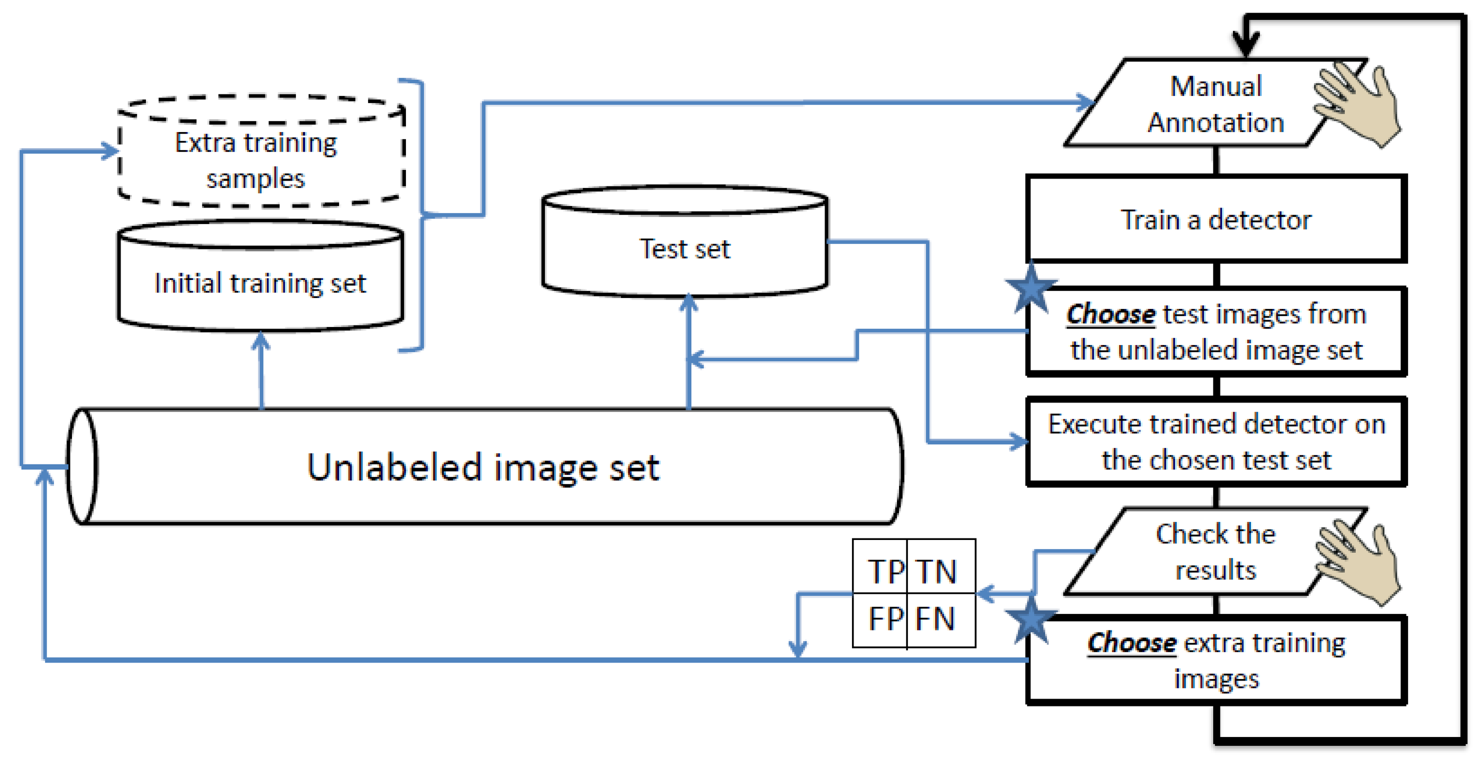
Use of orientation to be able to make a single detection on each image patch



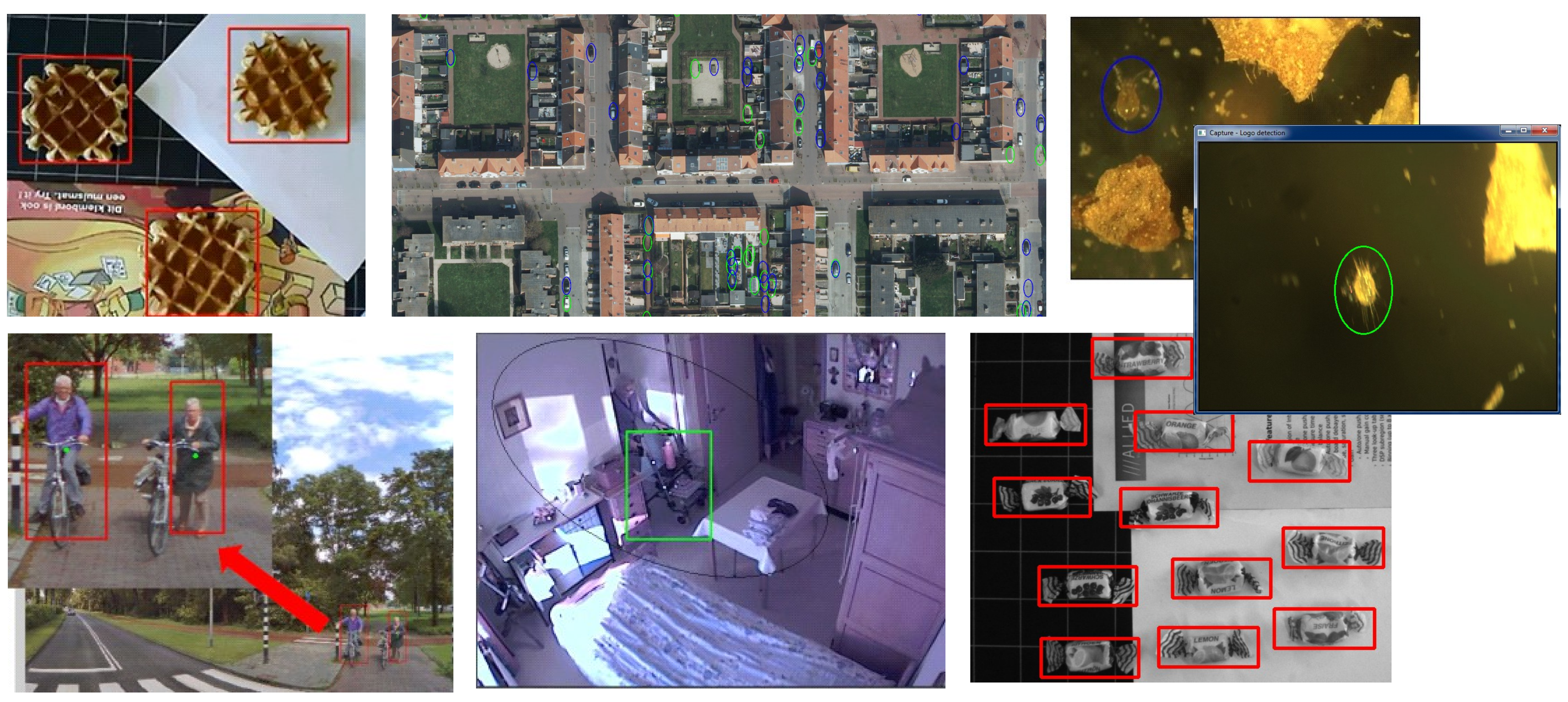
Innovative active learning strategy

Making use of a iterating active learning strategy that uses the application specific information gained from object and scene variation

- Results in less manual annotation and intervention
- Only the usefull training samples will be added to the system
- Try to find *'border'* samples by using the application specific knowledge



Experimental detection results



Expected outcome

At the end of the PhD research a complete new and innovative object categorization framework will be available that

- Uses the industrial application specific object and scene constraints
- Obtains an accurate and high detection rate of 99,9%

The resulting algorithm will stimulate the industry to actively use this technology for robust object detection on the one hand and will provide new insights for further research in academic context on the other hand.

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