Automatic analysis of eye-tracking data using object detection algorithms

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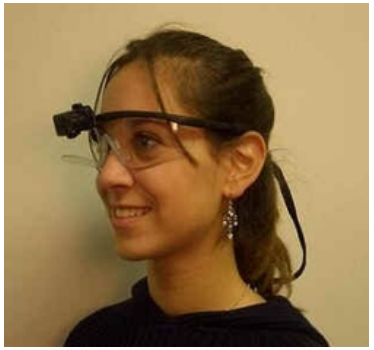
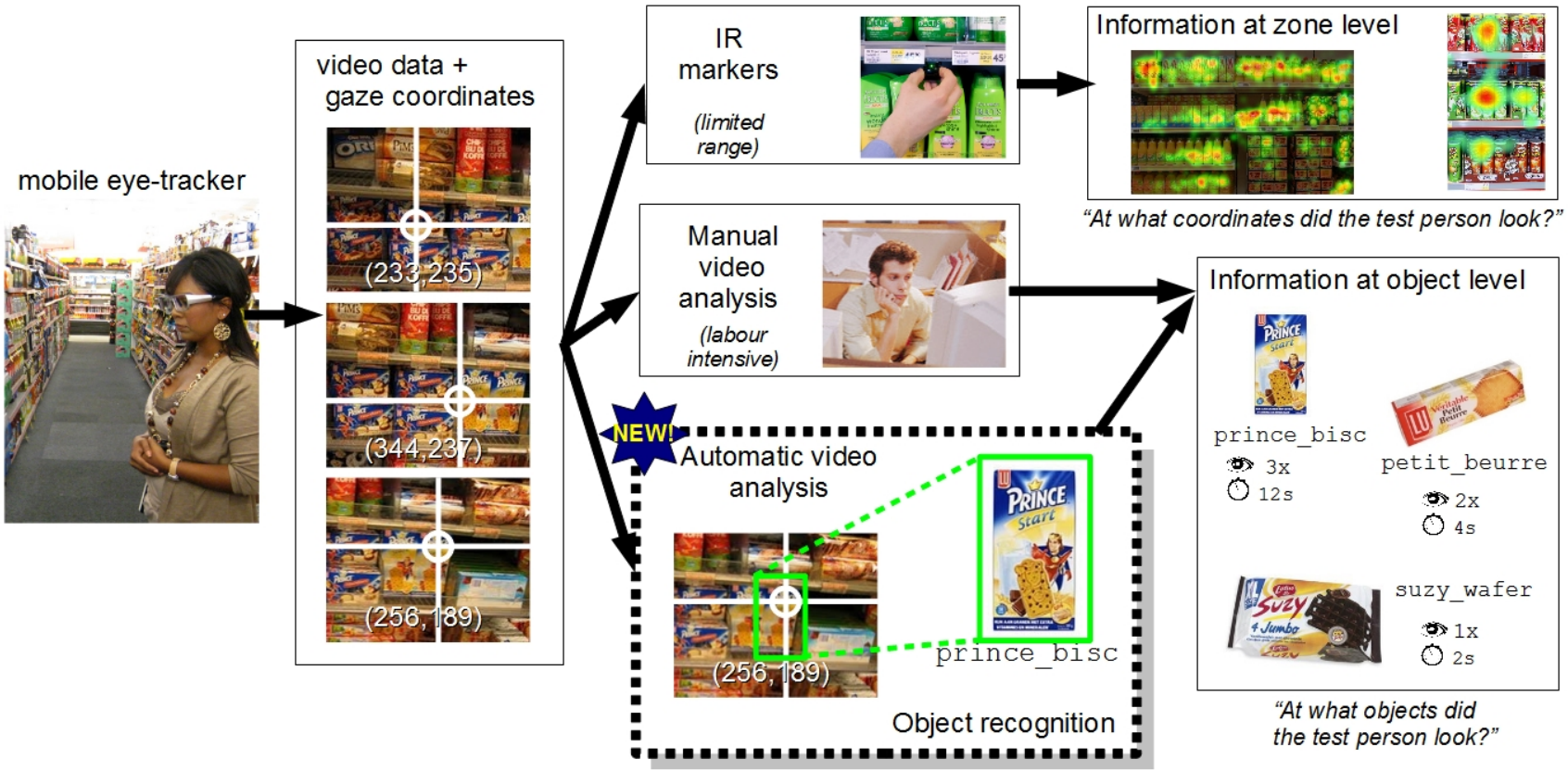
Introduction

- Mobile eye-tracker:
  - Big potential: natural environment, beyond lab conditions
    - Supermarket
    - Sports court
    - On the road



- Problem: ***manual*** data analysis
  - Large amounts of data
  - Existing methods for automatic processing not

Introduction



Content

- Introduction
- Proposed approach
- Suitable object-detection algorithms
- Experimental results
- Conclusion

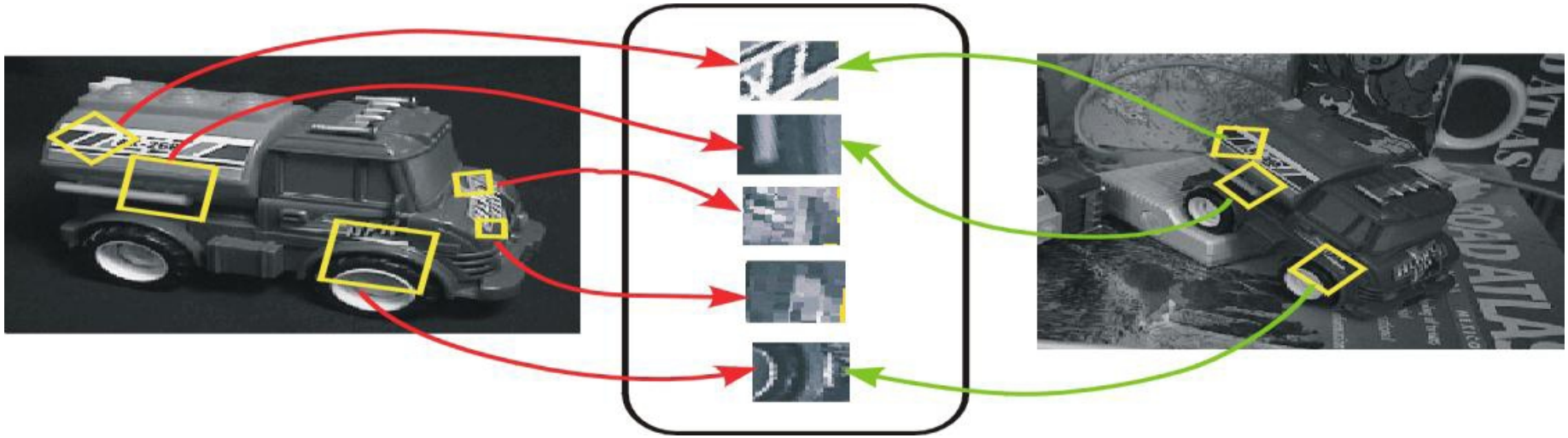
Proposed technique

- Object recognition algorithm automatically analyses video stream (with gaze data)

- Benefits:
  - Target of analysis is not restricted to a region
  - Objects can be moving
  - Manual labour limited

- Invariant region matching techniques:
  - Algorithm defines interest regions
  - Descriptor vectors invariantly describe visual content of regions
  - Features we use are invariant to translation, rotation and scale

Need for a reliable and distinctive features



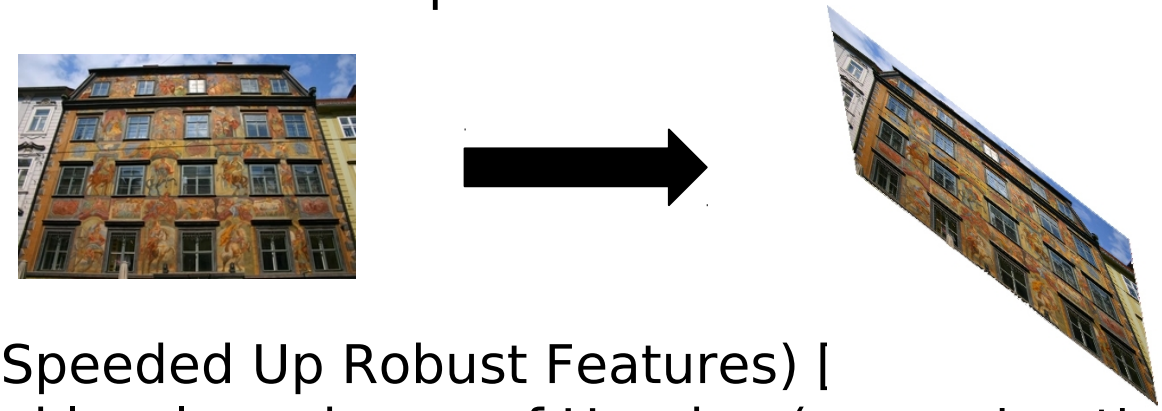
- What is a good feature:
  - Satisfies brightness constancy
  - Has sufficient (but not too much) texture variation
  - Does not deform too much over time

- Features can be used to match objects between two images

Overview suitable techniques

- SIFT (Scale-Invariant Feature Transform) [Lowe99]
  - Finds local maximum of Difference of Gaussian in space and scale

- ASIFT (Affine Scale-Invariant Feature Transform)
  - Affine invariant implementation of SIFT

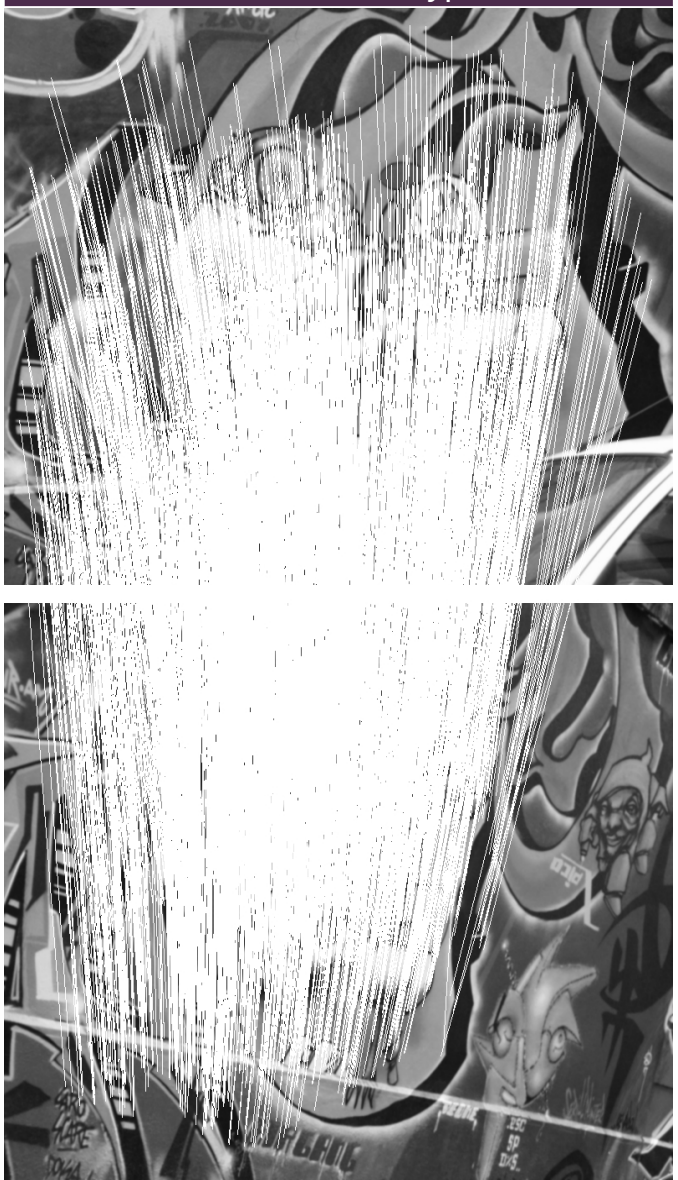


- SURF (Speeded Up Robust Features) [
  - Find local maximum of Hessian (approximation of Laplacian of Gaussian)
  - Uses integral images for major speed up

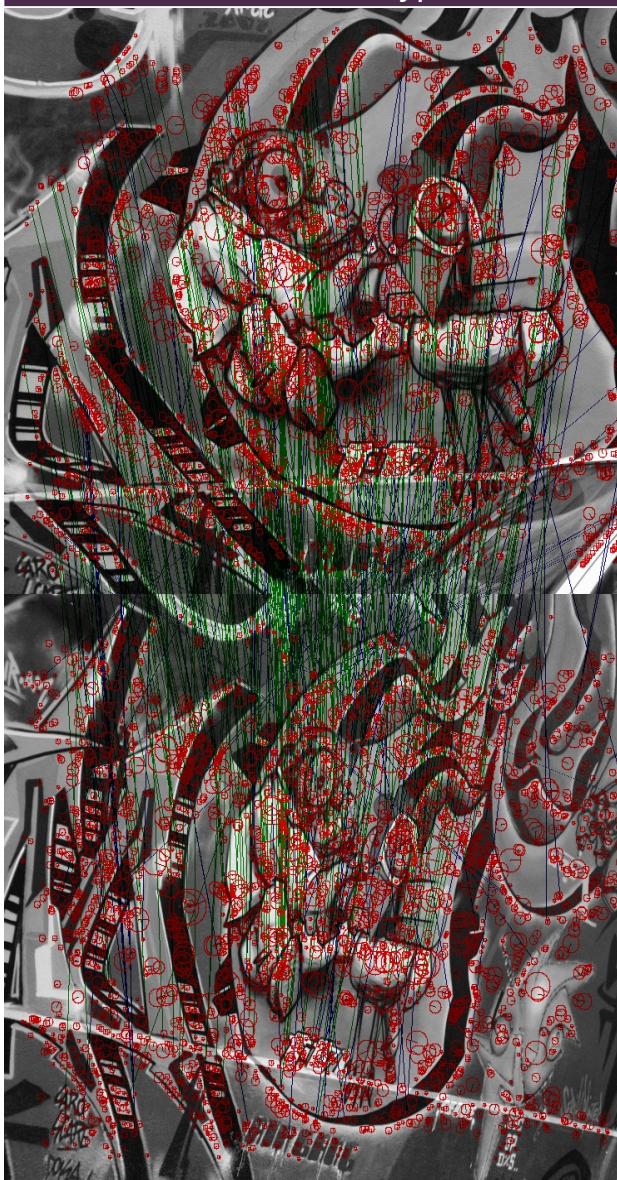
Overview suitable techniques

SIFT: 25 matches / Keypoints: 3189

ASIFT: 2270 matches / Keypoints: 34985



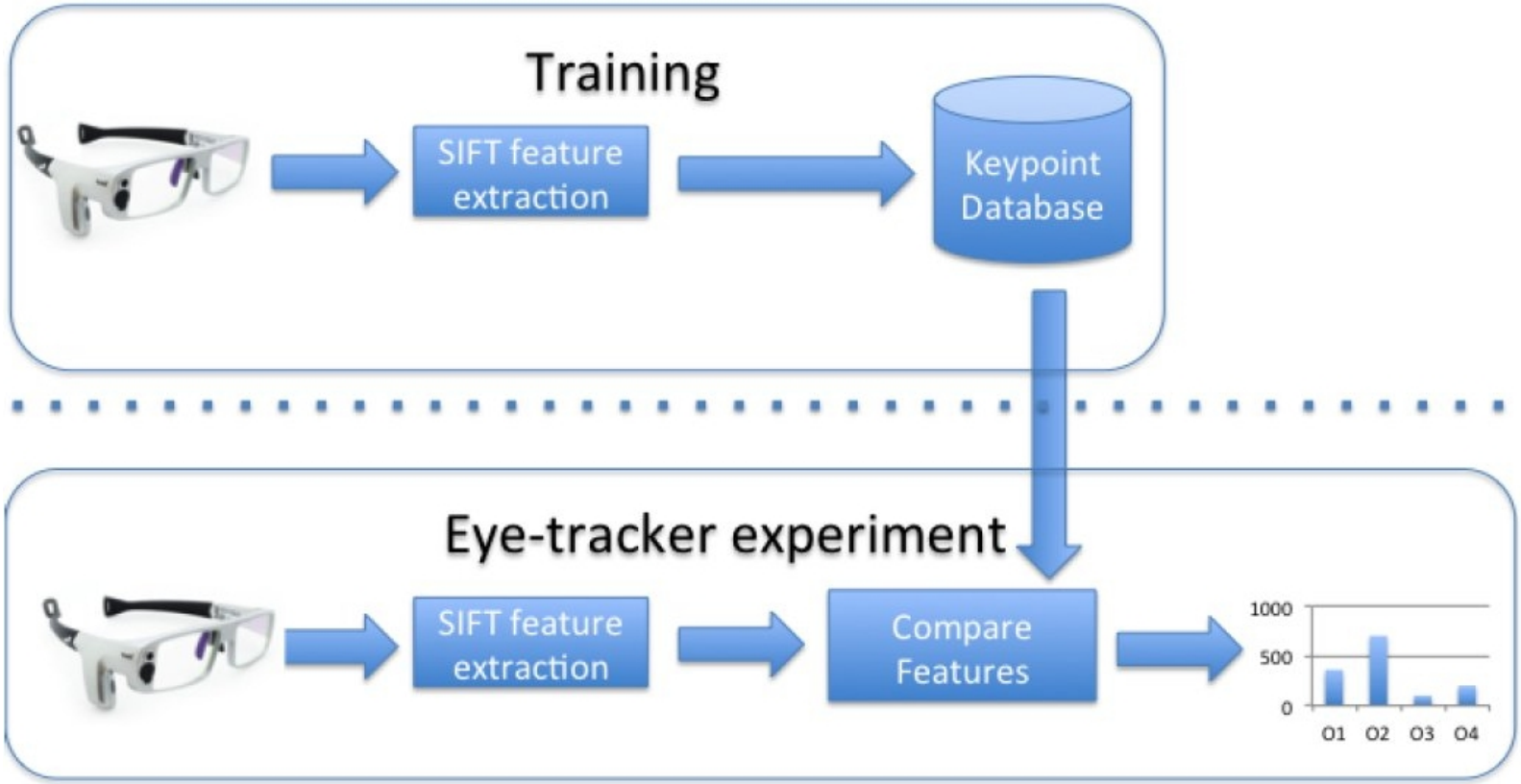
SURF: 259 matches / Keypoints: 3080



Comparative experiments

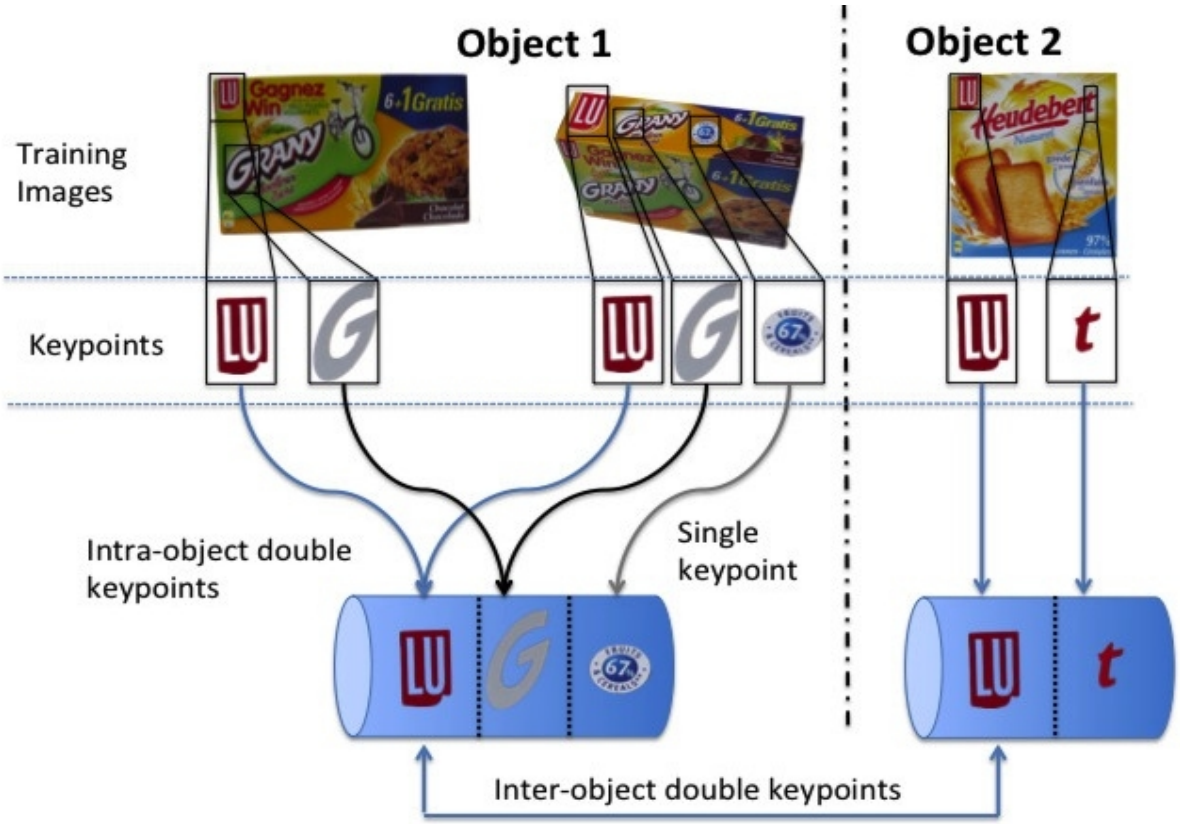
Algorithm	Rotation Invariant	Scale Invariant	Affine Invariant	Efficiency	Speed	#Keypoints	Correctness	Resistance to noise
SIFT	X	X		+++	++	++	+++	++
ASIFT	X	X	X	+++	+	+++	++	++
SURF	X	X		+++	+++	+	+++	+++

Overview approach



Clustering double keypoints

- Clustering of both inter- and intra-object double keypoints



Processing keypoint matches

- An object is recognized if:
  - It has the highest number of matches
  - This number exeeds a fixed threshold

- Statistics of each recognized object are stored:
  - How often the viewer fixated to that object
  - For how long it was fixated during the experiment

Graphical output

Conclusion

- Mobile eye-tracking hardware boom
  - Big potential: natural environment, beyond lab conditions
  - Datasets too large for manual analysis
  - IR-marker-based approaches not applicable in natural environments
- Proposed technique:
  - Object recognition algorithms for data analysis
  - Lots of benefits as compared to IR-markers
- Feasibility experiments
  - First results promising
  - Follow-up project started

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