

Computer Vision Systems Programming Multi-Camera Tracking Evaluation

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- Conclusion



What we wanted to do

- Goal: person detection / tracking with multiple cameras
 Chosen algorithm: KSP optimization by Berclaz et al.
 Questions to answer
 - Single camera performance / limitations
 - Performance scaling with multiple cameras



KSP optimization - introduction

- Recently published [2011] tracking algorithm
- Prototype code available online
- Two-step approach
 - Per-frame object detection / position estimation
 - \circ Linking and optimization

Object detection - approach

• Approach: If we see an object in the camera, what is the most likely position of that object in the scene?







Object detection - position estimation

- Approach: Opposite direction / optimize shape similarities
- Requirements
 - \circ Known object shape
 - \circ Calibrated cameras





What we did and how

• Pre-processing

- Camera alignment and configuration
- Camera calibration (intrinsic + extrinsic)
- \circ Tracker configuration
- \circ Test scene recording

Post-processing

- Video normalization
- Foreground detection (background subtraction)
- Tracker application
- Result visualization and comparison



What we did and how - camera setup

- We used the cameras at the CVL
 2 * Axis 211w, 2* Axis P1346, 2 * Sony CH140
 Aligned to produce particily everyoning views
- Ali gned to produce partially overlapping views
- Configuration: resolution, FPS, focal length, ...





What we did and how - camera calibration

- Interior orientation for modelling camera parameters
- Matlab camera calibration toolbox





What we did and how - camera calibration

- Exterior orientation for mapping object space with image space
 - \circ initial EO plane2plane homography
 - final EO minimization of reprojection error





What we did and how -ROI setup (1)

ROI - points represent cells' grid floor plane Z=0.00m cell size = 0.25m





What we did and how - Bounding box

Examplar bounding boxes
 bounding box size = 0.50 x 0.50 x 1.75m





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What we did and how - configuration file

 RECTANGLE <camera number> <location number> notvisible|<xmin> <ymin> <xmax> <ymax>

conf_ch140	0-1 — Notatnik 💷 💷 📈	-
Plik Edycja	Format Widok Pomoc	
RECTANGLE	3 81 267 179 325 381	
RECTANGLE	3 82 287 190 350 396	
RECTANGLE	3 84 332 214 405 427	
RECTANGLE	3 85 356 228 434 442	
RECTANGLE	3 86 381 243 463 458	
RECTANGLE	3 87 408 260 493 474	
RECTANGLE	3 88 notvisible	
RECTANGLE	3 89 notvisible	
RECTANGLE	3 90 notvisible	
RECTANGLE	3 91 notvisible	Ξ
RECTANGLE	3 92 notvisible	
RECTANGLE	3 93 91 123 132 269	
RECTANGLE	3 94 100 120 142 2/7	
RECTANGLE	3 95 110 130 134 200	
RECTANGLE	3 97 132 138 179 305	
RECTANGLE	3 98 144 142 193 316	
RECTANGLE	3 99 158 148 208 327	
RECTANGLE	3 100 173 154 224 339	
RECTANGLE	3 101 189 161 242 352	
RECTANGLE	3 102 207 168 261 366	
RECTANGLE	3 103 226 177 281 380	
RECTANGLE	3 104 246 187 305 395	
RECTANGLE	3 105 266 198 331 411	
RECTANGLE	3 100 28/ 211 338 42/	
RECTANGLE	3 108 334 241 417 461	
RECTANGLE	3 109 360 258 448 479	
RECTANGLE	3 110 notvisible	
RECTANGLE	3 111 notvisible	
RECTANGLE	3 112 notvisible	-



What we did and how - test scene recording

• Recorded scenes with 2-5 people standing / moving around





What we did and how - video normalization

• All video streams need to have

- \circ Identical resolution
- Identical framerate (!)
- All streams were normalized to 640*480 @ 20fps



What we did and how - foreground detection

- Tracker requires fg/bg segmented frames as input
- Foreground detection via background subtraction
 Codebook algorithm (OpenCV implementation)





What we did and how - tracker application

Input

 \circ Segmented frames for all camera views

• Config: object appearances for all positions and views

• Output

- Occupancy probability for every position and frame
 - Input to the second step of the tracker

0 0.000135422 1 0.000141084 2 0.00264496 3 0.0214263 4 0.999974 5 0.030795 6 0.0290455 7 0.02753



. . .

What we did and how - result visualization

• Visual evaluation - proper result visualization required



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Results ...

Conclusion

- Using multiple cameras improves performance noticeably
- Three cameras seems a good number in our case
- Performance varies greatly
 - Good performance with 1 or 2 people
 - \circ 4 and more people are problematic
 - Precise and complicated configuration required
 - Artefacts in segmented frames can cause false positives





Thank you ... Questions?