Detection and tracking of groups in crowd

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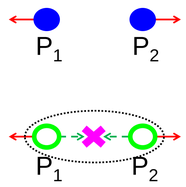
1. Motivation

- To understand the behaviour of interacting people
  - 50-70% of human walking activity takes place in groups [5]
- To detect group formations in crowd
- To discriminate potentially ambiguous group configurations

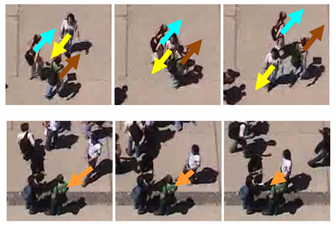
2. Social forces in a group of people

- Group detection [5]
  - non-interacting people: *repulsive forces* (account for interpersonal space [2])
  - interacting people: *repulsive + attractive forces* (account for interpersonal space and attraction among people in a group [3])



3. Group detection: challenges

- Ambiguous situations when a person get close to or cross a group
- *Person crossing a group* → possible group loss
- *Person approaching a group* → possible wrong group detection



4. Group detection

Legend: person not in a group | person in a group | group | group centre | repulsive force | attractive force | movement

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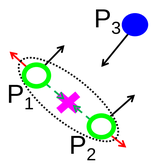

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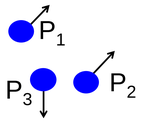

Sochman & Hogg [5]

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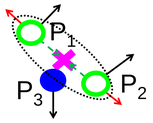
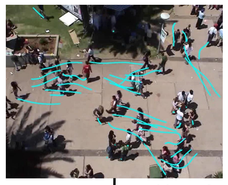


proposed approach

P_3 cancels out attractive forces

people walking in opposite directions: no interaction



Position of people

Detection of people crossing a group

Detection of groups [5]

Detecting of people approaching a group

Position of groups

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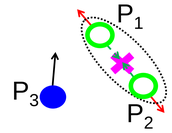

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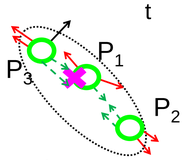

Sochman & Hogg [5]

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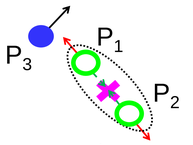


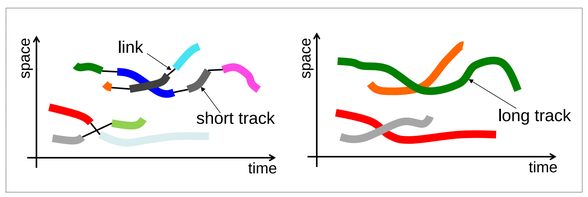
proposed approach

P_3 generates attractive forces

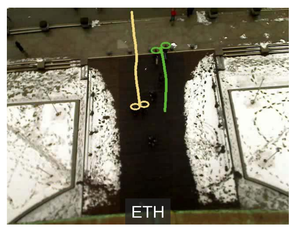
person passing by: no interaction

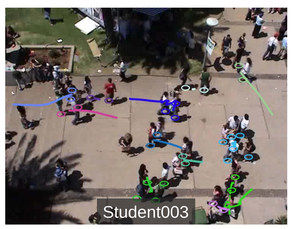
5. Group tracking

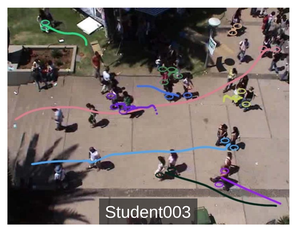
- Challenges
  - groups may be very close to each other
  - false negative group detections
- Short tracks
  - generated by sequentially associating group centres
  - method: Hungarian algorithm
  - features: position and velocity
- Long tracks
  - generated by linking the short tracks
  - method: graph-based approach [4]
  - pair-wise matching of short tracks until no alternative better pairings are found
  - latency: 25-frame buffers overlapping for 5 frames



6. Experimental results



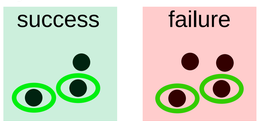




GDSR: Group Detection Success Rate [1,6]
- percentage of groups with 60% of the members correctly detected

Person in a detected group

Person in a ground-truth group



Gr-Det: group detection Gr-Track: group tracking

Dataset	Gr-Det [5]	our Gr-Det	Gr-Track on Gr-Det [5]	Gr-Track on our Gr-Det
ETH	77%	78%	78%	80%
HOTEL	78%	89%	81%	89%
Student003	58%	71%	60%	72%

7. Conclusions

- Contributions
  - group detection models that help coping with challenging situations (using direction and velocity)
  - group trajectories generated with a graph-based tracker (using position, velocity and short tracks)
- Future work
  - tracking with no latency for time-critical applications

References

[1] L. Bazzani, *et al.* Decentralized particle filter for joint individual-group tracking. IEEE CVPR, 2012
[2] D. Helbing, *et al.* Simulating dynamical features of escape panic. Nature, 407:487–490, Sep. 2000
[3] M. Moussaid, *et al.* The walking behaviour of pedestrian social groups and its impact on crowd dynamics. PLoS ONE, 2010
[4] F. Poiesi, A. Cavallaro. Detection and tracking of interacting targets. IEEE Trans. on Image Processing, *under review*, 2013
[5] J. Sochman, D. Hogg. Who knows who – inverting the social force model for finding groups. IEEE ICCVW, 2011
[6] M. Zanotto, *et al.* Online Bayesian nonparametrics for group detection. BMVC, 2012

YouTube video

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