

Pedestrian line counting by probabilistic combination of flow and appearance information

Master thesis initial talk

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October 14, 2014



Line (LOI) counting

Overview

- 1 Introduction
- 2 Relation to ROI counting
- 3 Line observation
- 4 Multiple lines and cells
- 5 Integration of LOI and ROI counters
- 6 Work schedule

Uses

Useful for

- Safety of crowds
- Security, crime prevention
- Urban planning
- Statistics for business owners
- ...

Can't be used for

- Identification
- Tracking

Input / output

Input at training time

- RGB video (≈ 24 fps)
- Ground-truth trajectories
- Camera parameters (sometimes)
- A line segment

Input at test time

- Video from the exact same vantage point
- (Or video at a similar location? How similar?)

Required output

- Cumulative number of line-crossings
- Leftward and rightward separately

Goals

Want to

- Avoid large error accumulation
 - Assuming additive error, the estimate takes a random walk (error $\mathcal{O}(\sqrt{\text{time}})$)
- Estimate online (don't "look ahead" much)

Not so crucial

- Exact time of each crossing not so important
- Real-time solution not realistic in crowded cases

Difficulties

- Occlusion
- People walk closely to each other
- Perspective



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Related: ROI counting

LOI counting by a ROI counter?

- Consider when a ROI counter says: there are 10 people in every frame
 - How much was the people flow? No way to tell!
 - What if we subdivide the image to cells? Still ambiguous!
- We need motion information that tells us
 - what is going on over the lines
 - which lines experience much flow and what crosses them

Main cues

Appearance: region observation

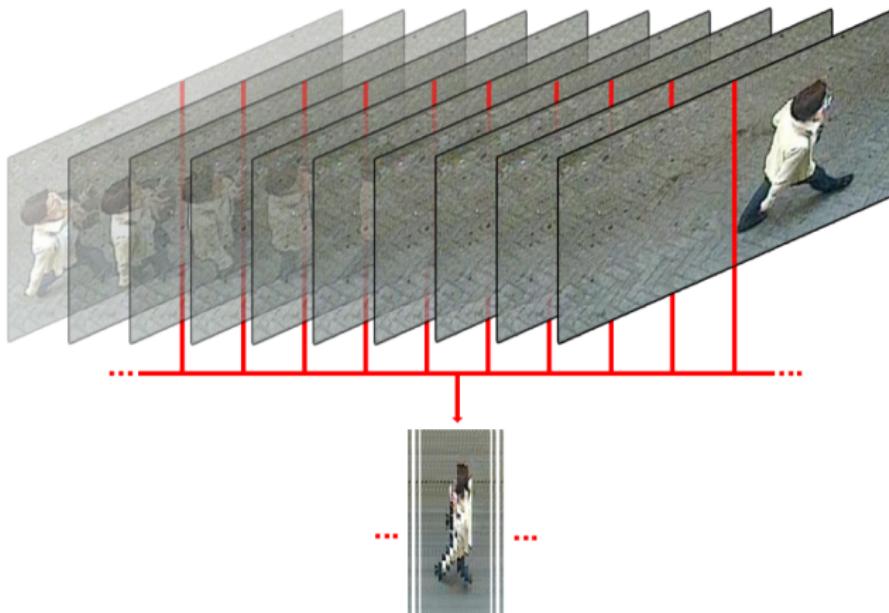
- Foreground segment size and shape
- Other low-level features (texture, edges, colors)
- Interest points
 - Could encode recurring cues such as heads or shoes

Motion: line observation

- What happens on the line over time?
- Movement direction and speed: Optical flow
- What is crossing: Spatio-temporal slice in RGB video, Canny video, feature videos

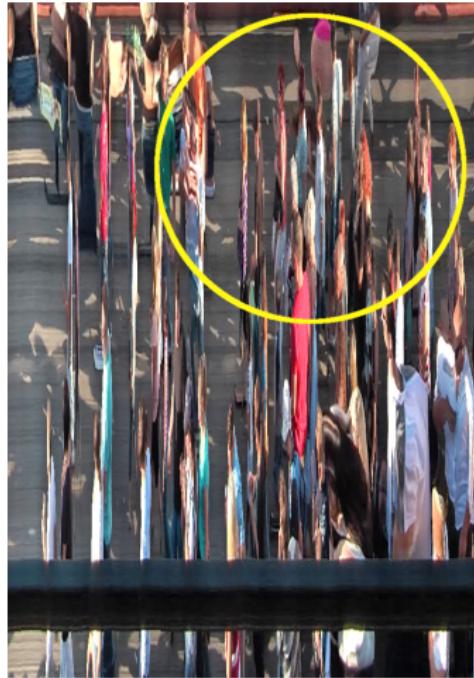
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Spatio-temporal slicing

Source: Benabbas et al. [2]



Slicing result

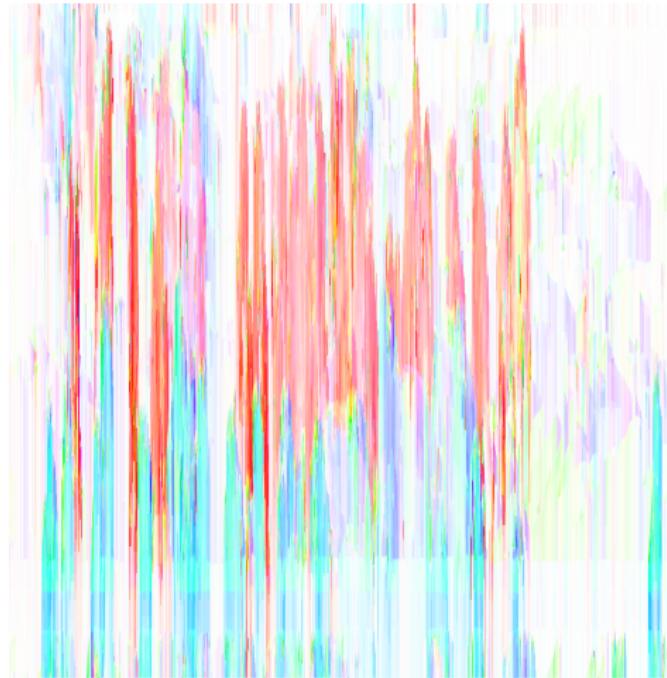
Optical flow

Flow information needed for:

- Leftward vs. rightward movement
- Weighting for “size reconstruction”

Opt. flow be calculated in many ways. E.g. variational methods.



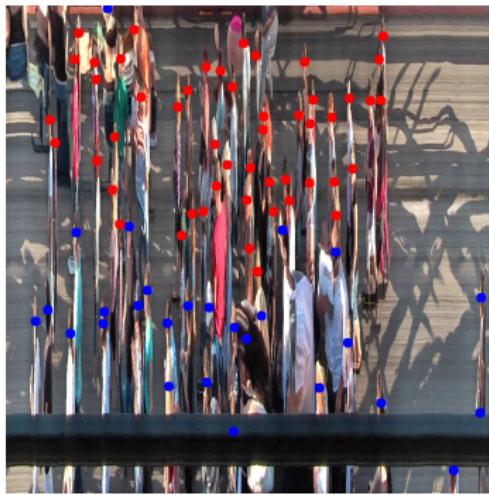


Color coded flow (spatiotemporal)

Learning a line counter

Line counter by regression:

- Take time-windows of about 30 frames
- Extract a feature vector from the left (and right) moving segment
- Desired output is the number of crossing heads

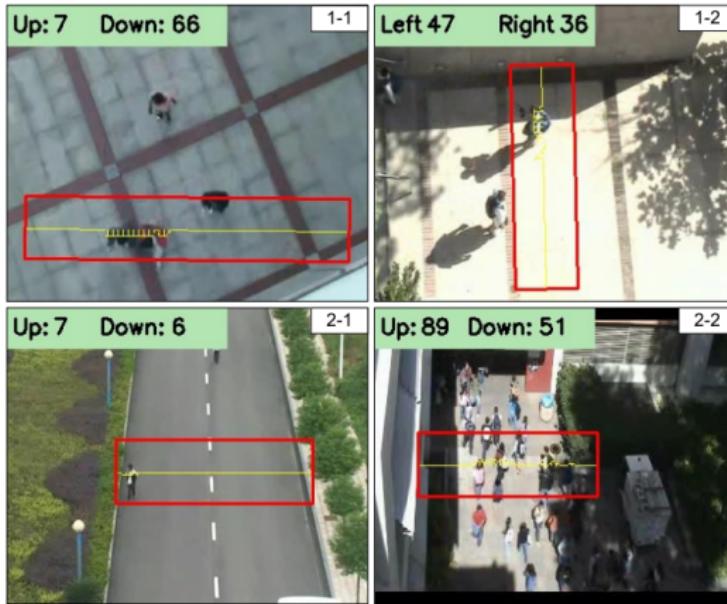


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Why do we need multiple lines?

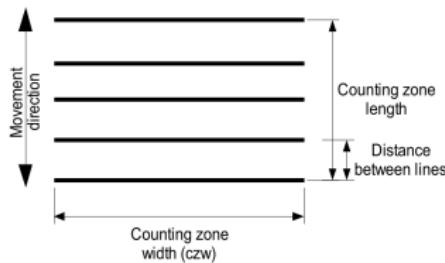
Some approaches only observe a single line



Source: Yang Cong et al. [3]

Why do we need multiple lines?

- Single line: we see each person/group in only one “occlusion configuration”
- If someone is occluded at that moment, no chance of counting them
- Multiple lines: More opportunity to see them separately
- Existing approach with multiple lines (uses a voting scheme)



Source: Barandiaran et al. [1]

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Integrating line and cell observations

Overall idea

- ① Create ROI counter
 - ② Create LOI counter
 - ③ Give them input from a grid arrangement (cells and borders)
 - ④ Combine outputs to get a single estimate
-
- Intuition for combination: Consider if
 - LOI counters on the border may “hallucinate” extra people entering
 - ROI counter’s estimate does not increase
 - → More robustness!
 - Can also be seen vice versa: LOI counting improves the ROI counter

Example scenario

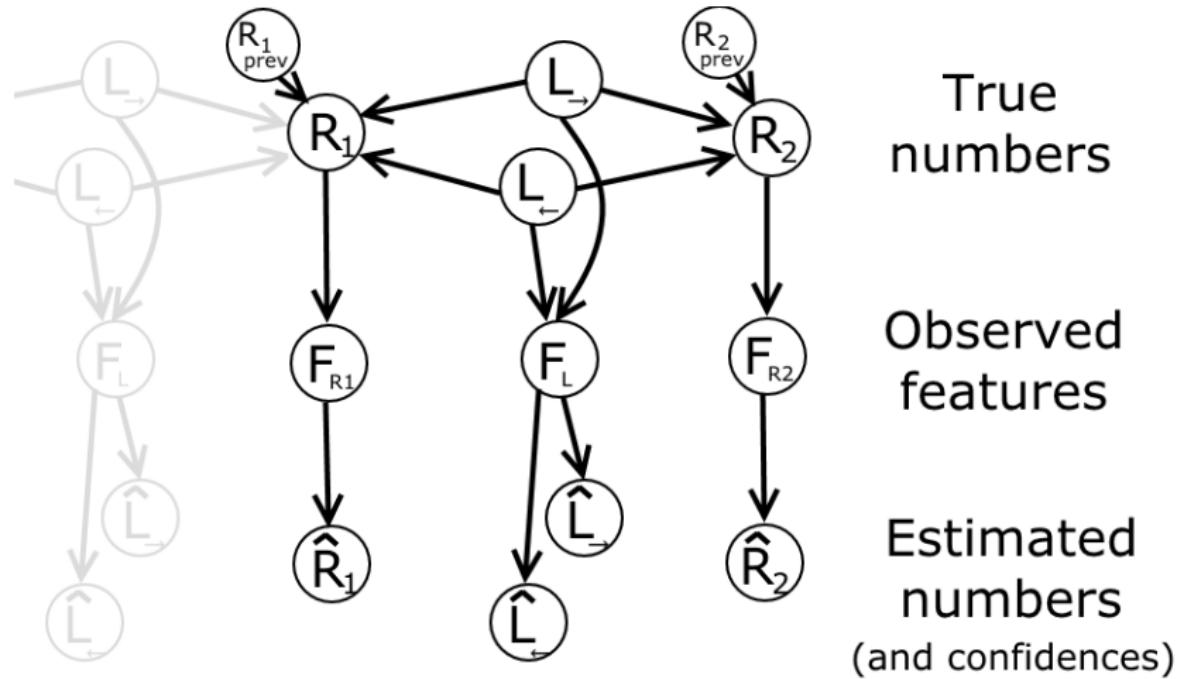


Line vs. cell count disagreements

- In case of disagreement: how do we decide?
- Use a graphical model that considers the error characteristics of the estimators and comes up with a consistent assignment of cell counts and line crossing counts
- Also: manually analyze why and when such disagreements happen

Graphical model for combination

Exact structure not decided yet.



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Work schedule (26 weeks)

- Familiarize with the subject and search literature
- Prepare and annotate datasets (2 weeks)
- Between-cell (LOI) people flow estimation (5 weeks)
- In-cell (ROI) people counting (5 weeks)
- Probabilistic graphical model framework (5 weeks)
- Additional improvements and experiments (3 weeks)
- Write (6 weeks)

References

-  **Javier Barandiaran, Berta Murguia, and Fernando Boto.** "Real-Time People Counting Using Multiple Lines". In: *2008 Ninth International Workshop on Image Analysis for Multimedia Interactive Services*. IEEE, 2008, pp. 159–162.
-  **Yassine Benabbas and Nacim Ihaddadene.** "Spatio-temporal optical flow analysis for people counting". In: *Advanced Video and ...* (Aug. 2010), pp. 212–217.
-  **Yang Cong, Haifeng Gong, Song-Chun Zhu, and Yandong Tang.** "Flow mosaicking: Real-time pedestrian counting without scene-specific learning". In: *2009 IEEE Conference on Computer Vision and Pattern Recognition*. IEEE, June 2009, pp. 1093–1100.

That's it

Thank you! — Questions?