

A Novel Self Organizing Network to Perform Fast Moving Object Extraction from Video Streams

Dizan Vasquez Thierry Fraichard Christian Laugier

Team e-Motion
<http://emotion.inrialpes.fr>
GRAVIR/INRIA/CNRS
France

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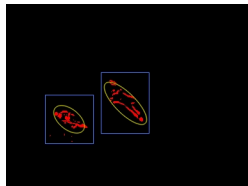
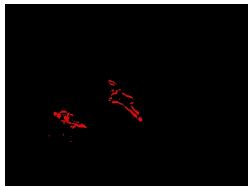
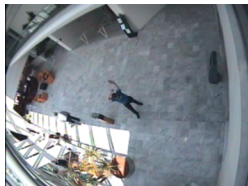
Outline

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- 2 Existing Approaches
 - Connected Components
 - Morphological Operators
 - Clustering Approaches
- 3 Proposed Approach
 - Overview
 - The SON
 - Connected components
- 4 Experimental Results
 - Experiments
 - Example Video
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Objective

Objective

Identify individual objects from pixels in a binary image.

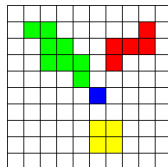
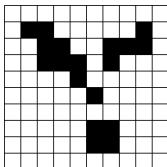


Connected components

How it works?

Principle

- Neighbor pixels belong to the same object.



Connected components

pros/cons

Pros

- Fast, $O(I_{width} \times I_{height})$ operations.

Cons

- One real object may correspond to many connected components.



- One connected component may correspond to many real objects.

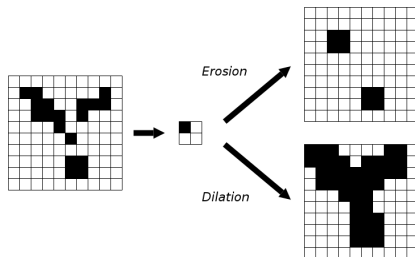


Morphological operators

How they work?

Principle

- 1 Preprocess pixels by applying simple mask-based filters.
- 2 Extract connected components.



Morphological operators

pros/cons

Pros

- Performs better than connected components on noisy conditions.
- Fast for small masks $O(I_{width} \times I_{height} \times M_{size})$.

Cons

- Performance degrades quickly in the presence of noise.
- Ah-hoc procedure / not driven by optimality criterion.

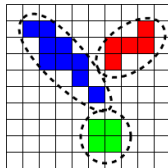
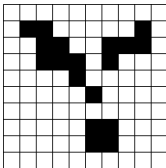


Clustering approaches

How they work?

Principle

- Consider foreground pixels as individual vectors $[x, y]$.
- Apply a conventional clustering algorithm (eg k-means, competitive learning).



Clustering approaches

pros/cons

Pros

- Robust to noise.
- Solid theoretical framework.

Cons

- Slower than other methods (depends on the algorithm).
- Require knowing the number of objects to find *a priori*.

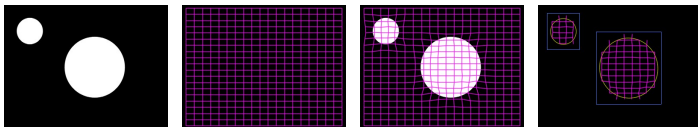


Overview

Principle

Combines the advantages of connected components + clustering:

- 1 Uses a custom SON to decompose the image in smaller regions.
- 2 Finds connected components in the SON:
 - Probability of being in the foreground.
 - Probability that two regions belong together.

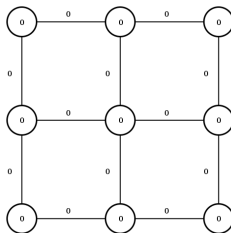


The SON

Description

SON elements

- **Nodes** arranged in a $W \times H$ two-dimensional grid, joined by **links**.
- Nodes have associated 2D vectors or **weights** representing their positions.
- Nodes and links have associated **win counters**.



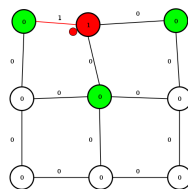
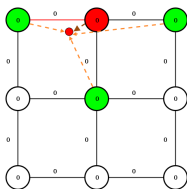
The SON

Updating the weights

Steps

For every foreground pixel:

- 1 Find the **winning node and link**.
- 2 Increment winning node and link *win counters*.
- 3 Move the winning node strongly towards the pixel.
- 4 Move winning node's **neighbors** weakly towards the pixel.

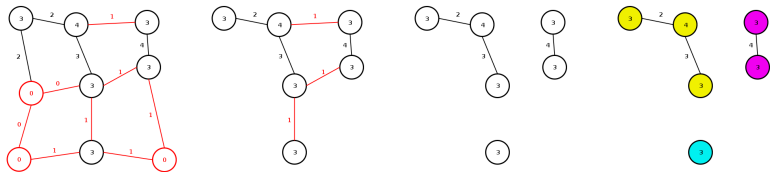


Connected components

Finding connected components

Steps

- 1 Compute nodes and link probabilities.
- 2 Delete nodes (and their links) having low node probabilities.
- 3 Delete links having low link probabilities.
- 4 Find connected components in the resulting graph.



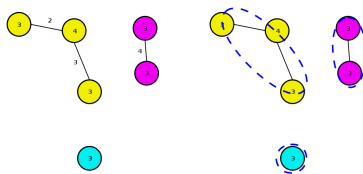
Connected components

Representing objects as gaussians

Steps

For every group:

- 1 Compute mean value and covariance based on node probability and position.



Experiments

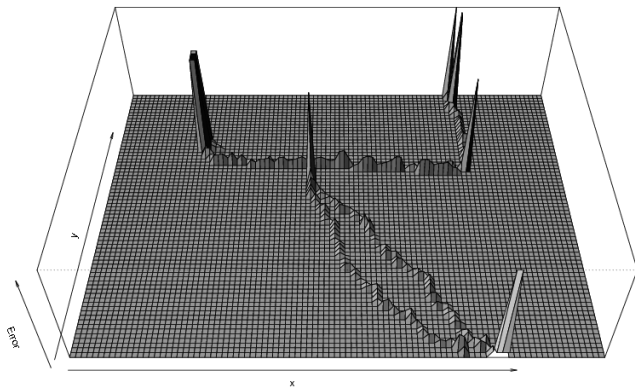
Experiments

- Tested on CAVIAR data (videos + ground truth).
- Background subtraction using consecutive frame difference.
- Average time x frame 14ms (object extraction only).
- No false negatives (except when the object stops).
- Some detected pedestrians which were not in ground truth (they were in the video!).
- Low false positive rate.



Experiments

Detection Error Graph



Browse2



Example Video



Conclusions and Future Work

Conclusions

- Robust to noise.
- Automatically finds the number of objects.
- Slower than other approaches
 $O(I_{width} \times I_{height} + \#fg \times S_{width} \times S_{height})$.
- But still faster than frame rate.

Future Work

- Optimize the algorithm. $O(I_{width} \times I_{height})$ seems feasible!
- Perform full image segmentation.
- Apply to occupancy grids.



Thank you!

