edge detection by
selection of pieces of level sets

enric meinhardt llopis

departament de tecnologia
universitat pompeu fabra

17–5–2008

Outline

Outline

The original DMM edge detector

- Edges are modelled as independent samples of points over the gradient image
- Pieces of level lines are fed to this model
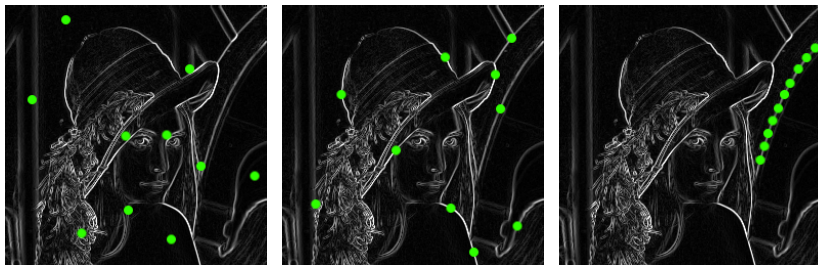
Statistics   *Geometry*

Results of the original DMM edge detector

Results of the original DMM edge detector

Problem with the original DMM edge detector

- There are too many edges!

A naïve solution to reduce the number of edges

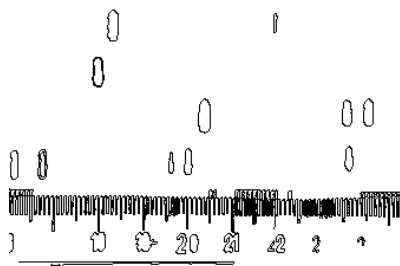► Random selection of some meaningful edges

300 curves   100 curves   50 curves

A naïve solution to reduce the number of edges

- ▶ Random selection of some meaningful edges

300 curves

40 curves

Outline

Smarter-than-random selection of meaningful edges

inspiration

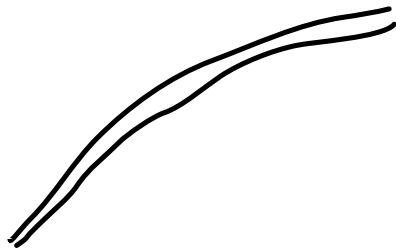- What do they do for segment detection?: (they pick a representative for each bundle of parallel overlapping segments)

criterion

- **Impose that each pixel may only be crossed by one output curve**

algorithm

- Greedily select meaningful edges while the criterion can be fulfilled
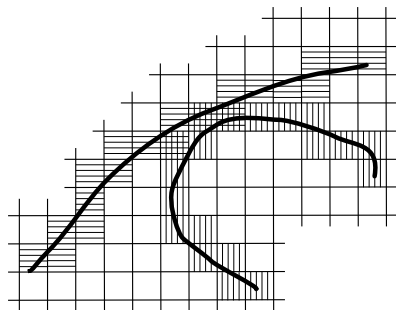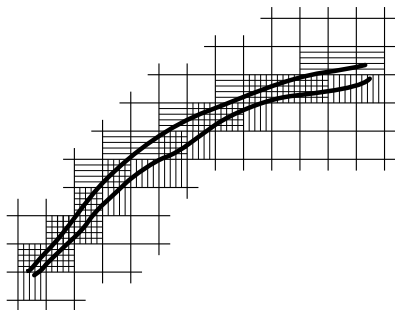
Detalied explanation of the exclusion principle
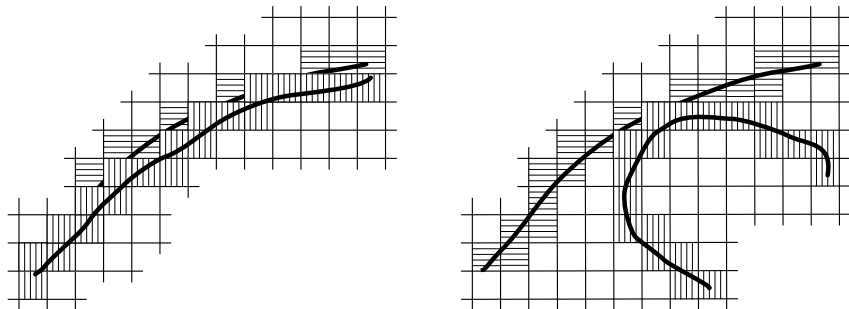

two curves "covering the same object"

two curves "covering different objects"

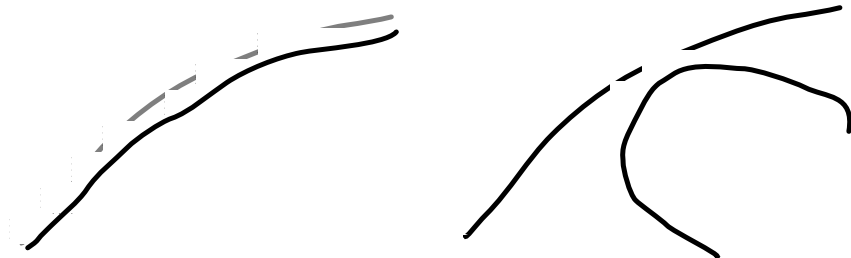# Detalied explanation of the exclusion principle

marking of the squares according to which curve crosses each one

Detalied explanation of the exclusion principle

Assignment of at most one curve to each square

Detalied explanation of the exclusion principle

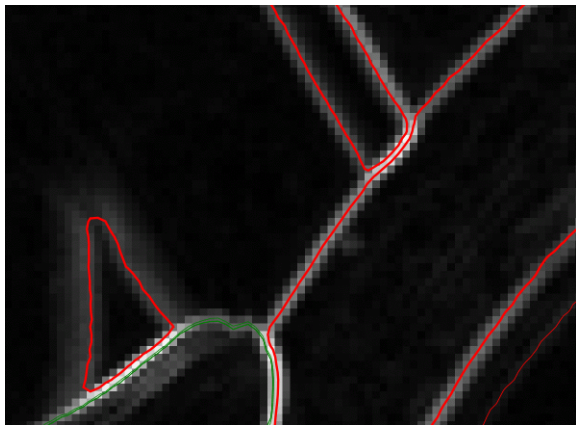Run of the *NFA* test for the remaining pieces of curve

Exclusion principle results
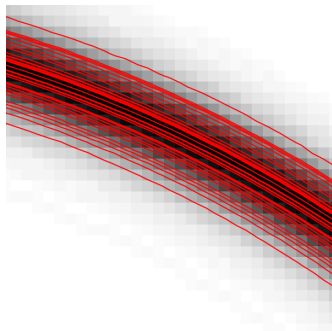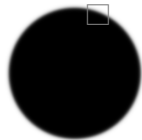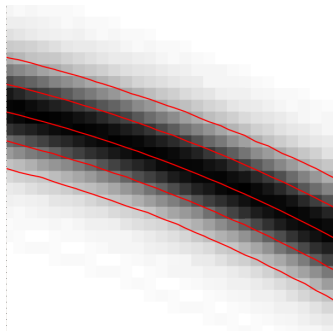

3373 curves

59 curves

detail

Exclusion principle results

244 curves

5 curves

Discussion about exclusion principle

- **Redundancy removal:** greatly reduces output size
- **Faithfulness:** no edges are lost
- **Remaining redundancy:** wide edges are still over-represented
- **Scale dependency:** edges which are W pixels wide are represented W times

How to remove the remaining redundancy?

two possibile approaches

- Look directly for wide edges
- Coupling with Canny

we settled on the second option

Outline

Recalling Canny's filter

- Select points where the norm of the gradient is maximal in the direction of the gradient
- Implemented using non-maximum suppression on the gradient image
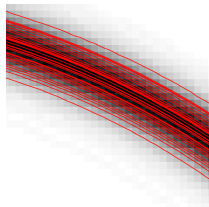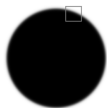

$\geq$

Coupling Canny and DMM

Really simple idea: Take DMM and use Canny's filter in place of the norm of the gradient.

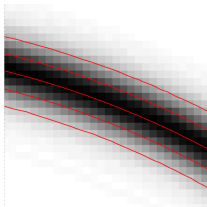## four resulting algorithms

- **DMM** Original algorithm
- **DMM/X** DMM with exclusion principle
- **DMM/Canny** DMM using Canny instead of gradient
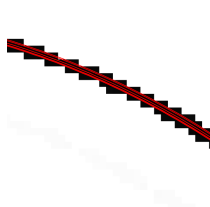- **DMM/Canny/X** DMM/Canny with exclusion principle
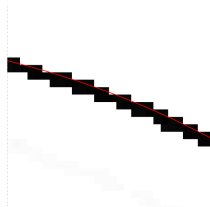
DMM/Canny results

DMM
244 curves

DMM/X
5 curves

DMM/Canny
101 curves

DMM/Canny/X
1 curve

DMM/Canny results
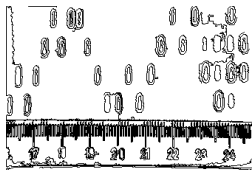

DMM
3373 curves

DMM/X
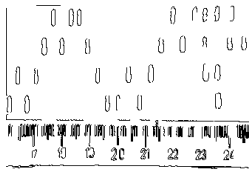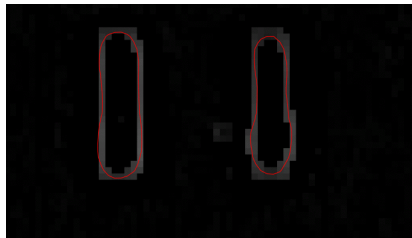59 curves
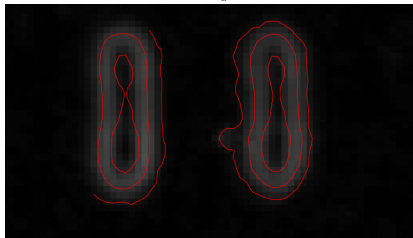
DMM/Canny
3198 curves

DMM/Canny/X
88 curves

DMM/Canny results

DMM/X:
85 curves

DMM/Canny/X
57 curves

Conclusion

- Original DMM algorithm produces a bundle of curves for each edge
- Proposed exclusion principle picks best representatives of each bundle
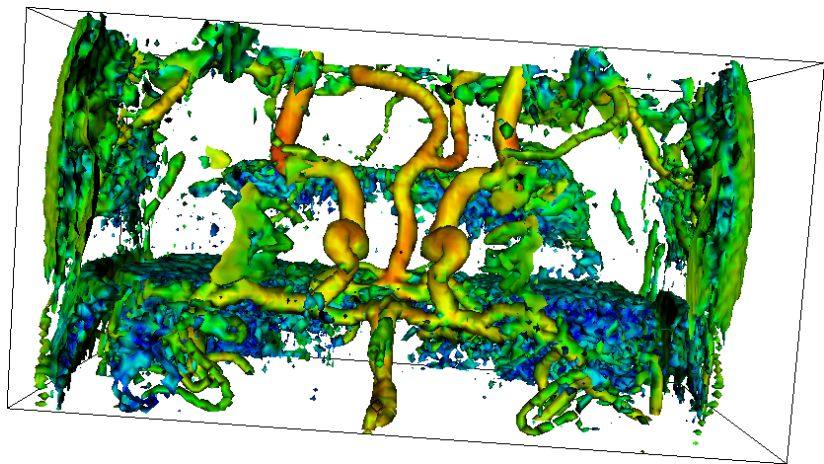- Proposed use of Canny's filter makes the bundles narrower

Outline
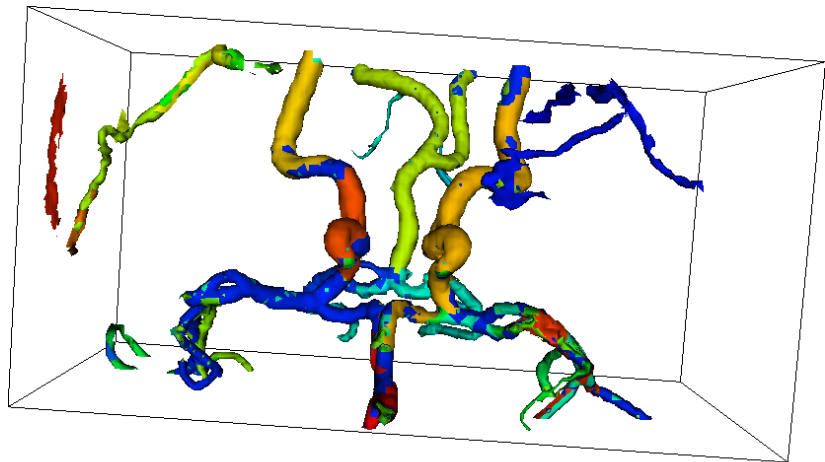
3D results
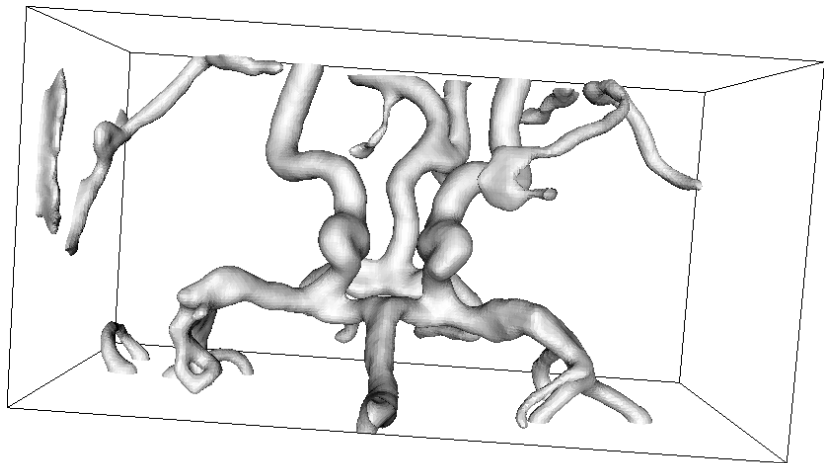

manually selected isosurface of a magnetic resonance image

result of our algorithm on a MRI

3D results

result of edge linking

Necessity of pieces of level lines

A well-contrasted image none of whose level curves is meaningful