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Real Projective Plane Mapping for Detection of Orthogonal Vanishing Points

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Motivation

- Camera orientation/localization
- Video compass
- Navigation
- …

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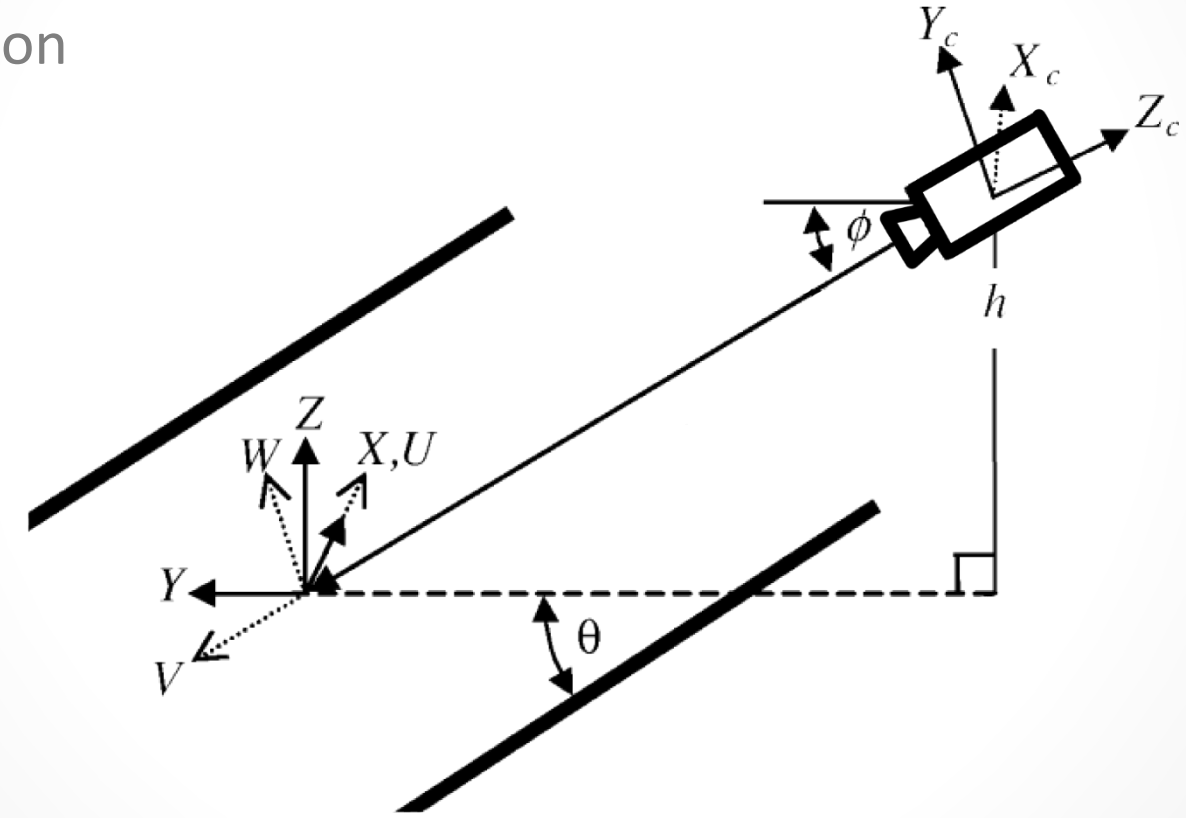

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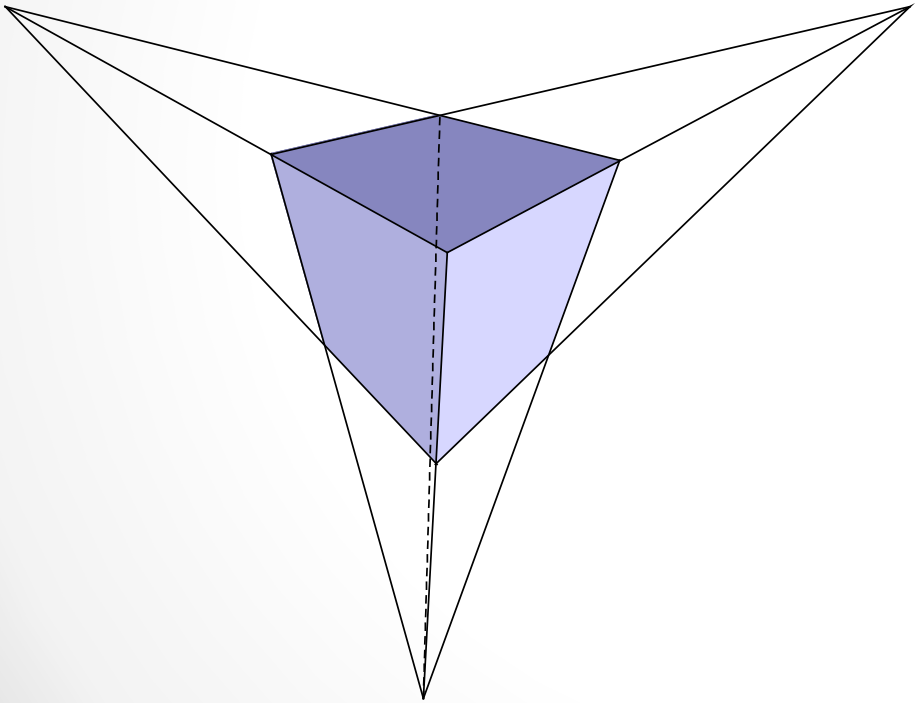
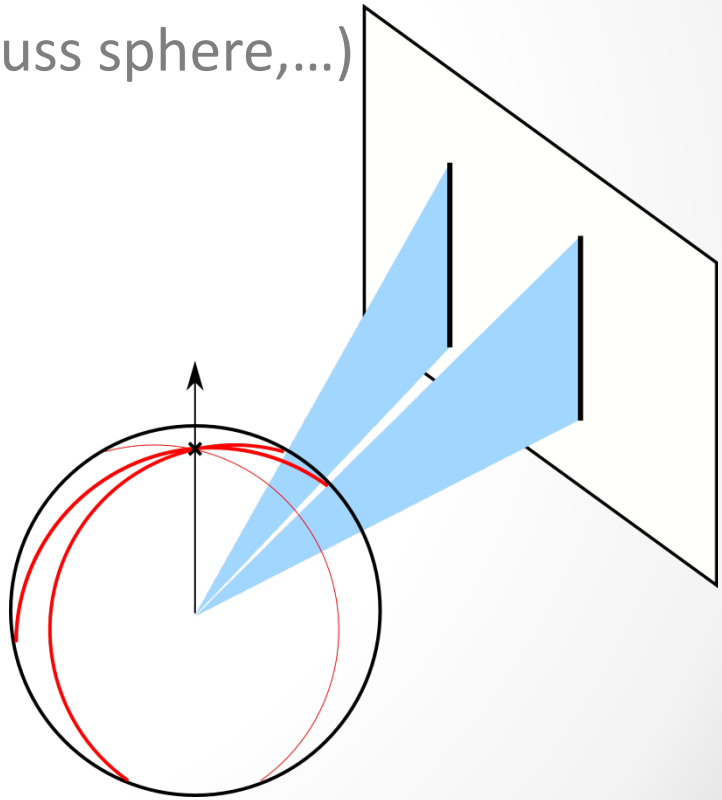
Vanishing Points

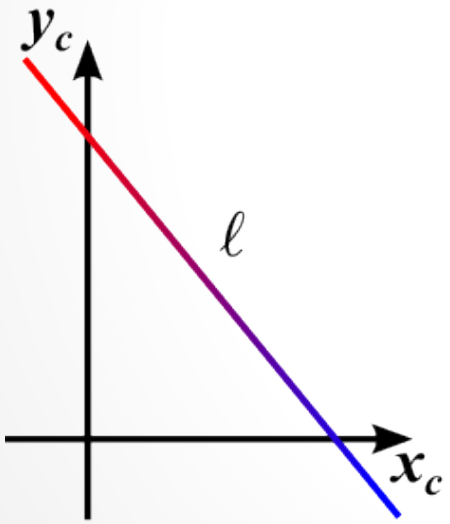
- Manhattan worlds
- Parallel lines in 3D can intersect after perspective projection to 2D
- Vanishing points (regular/ideal, gauss sphere,…)

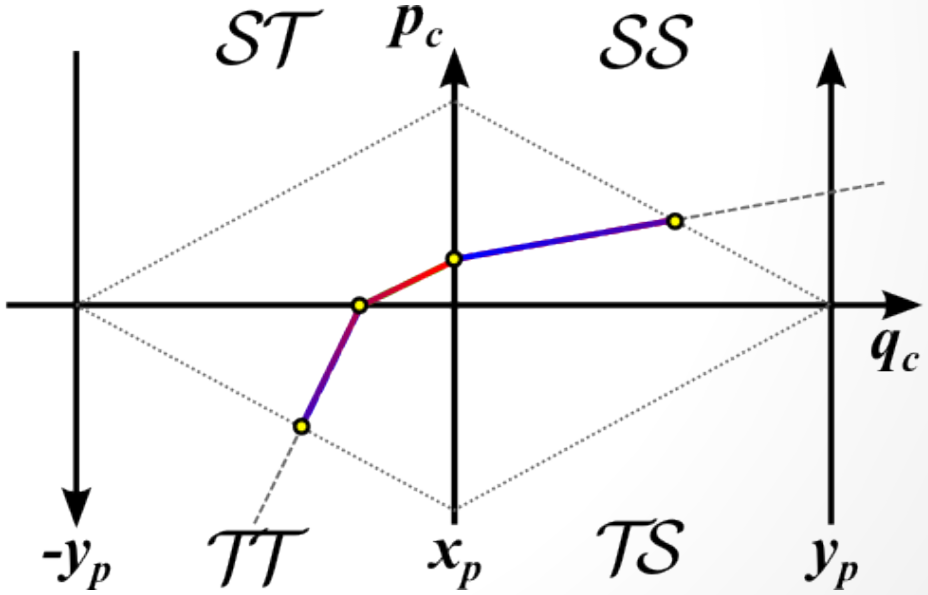




Our Solution

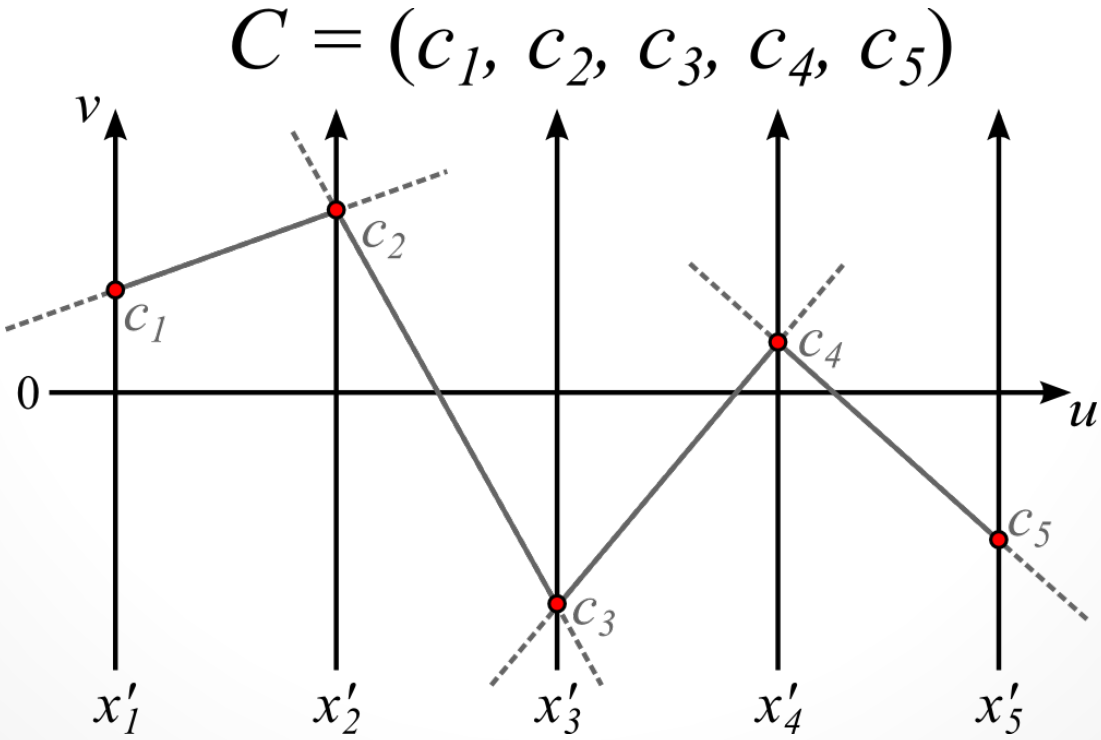
- Hough based method
- **Piecewise linear mapping**
  - Line is mapped to a **polyline**
- Regular/ideal point is mapped to a **regular** point





Parallel Coordinates

- Coordinate axes are mutually parallel
- A point is represented by a polyline



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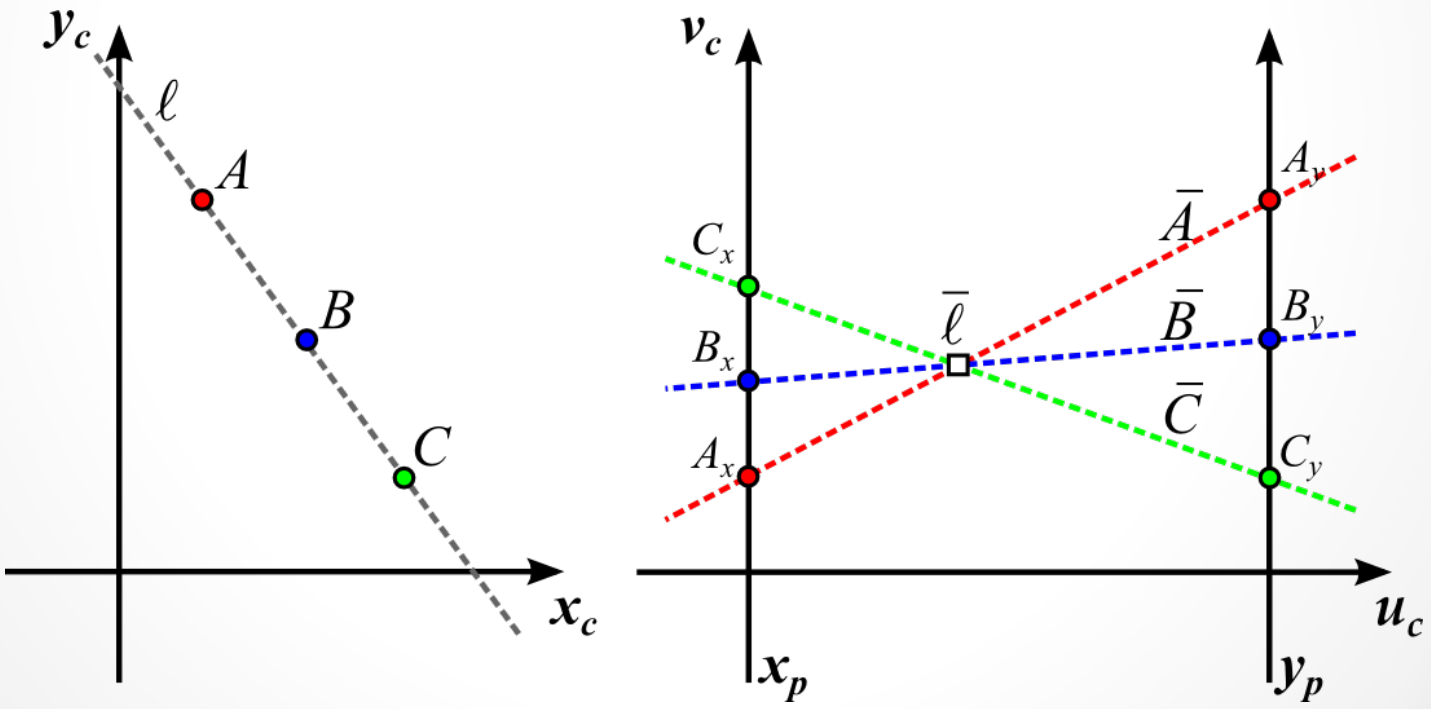

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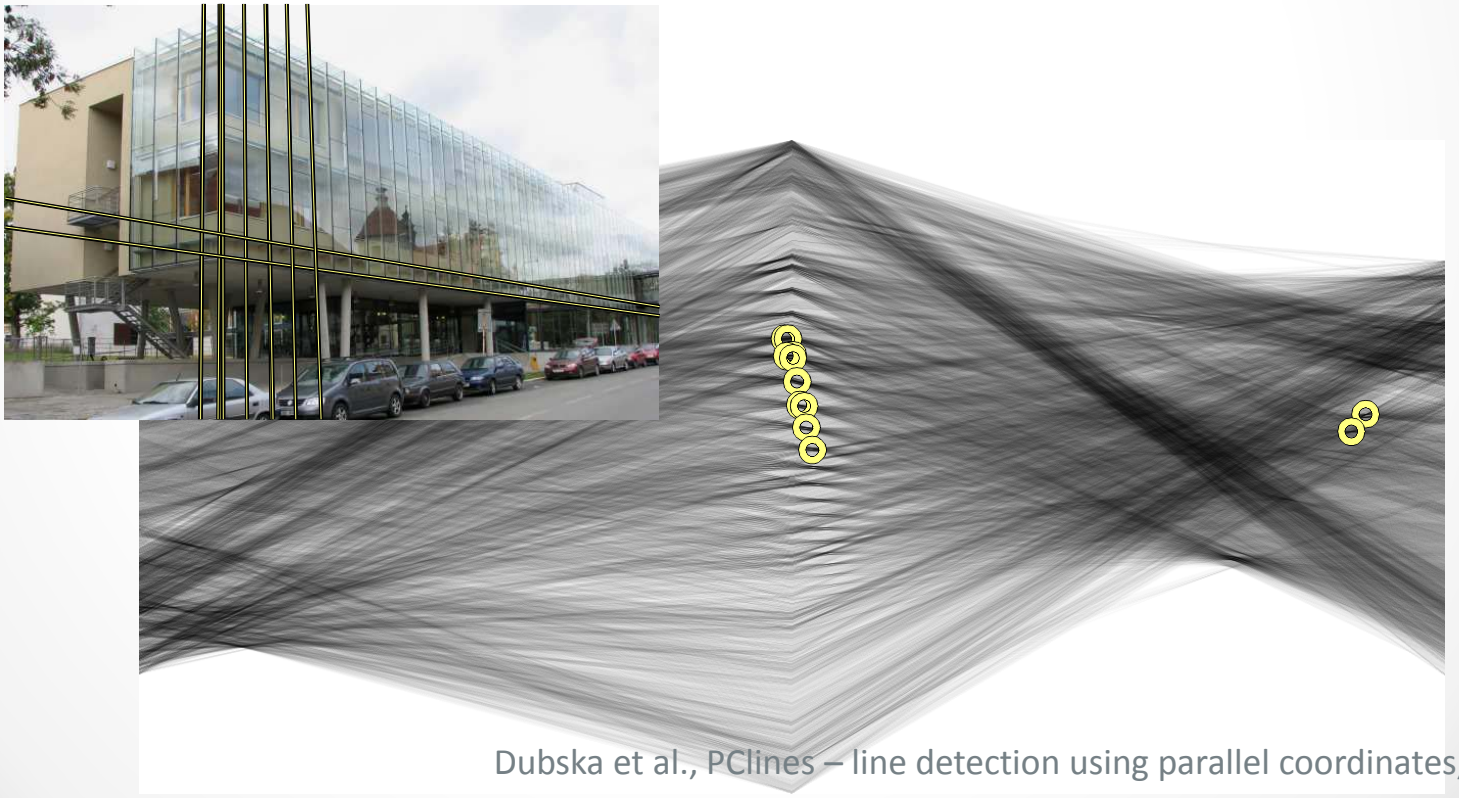
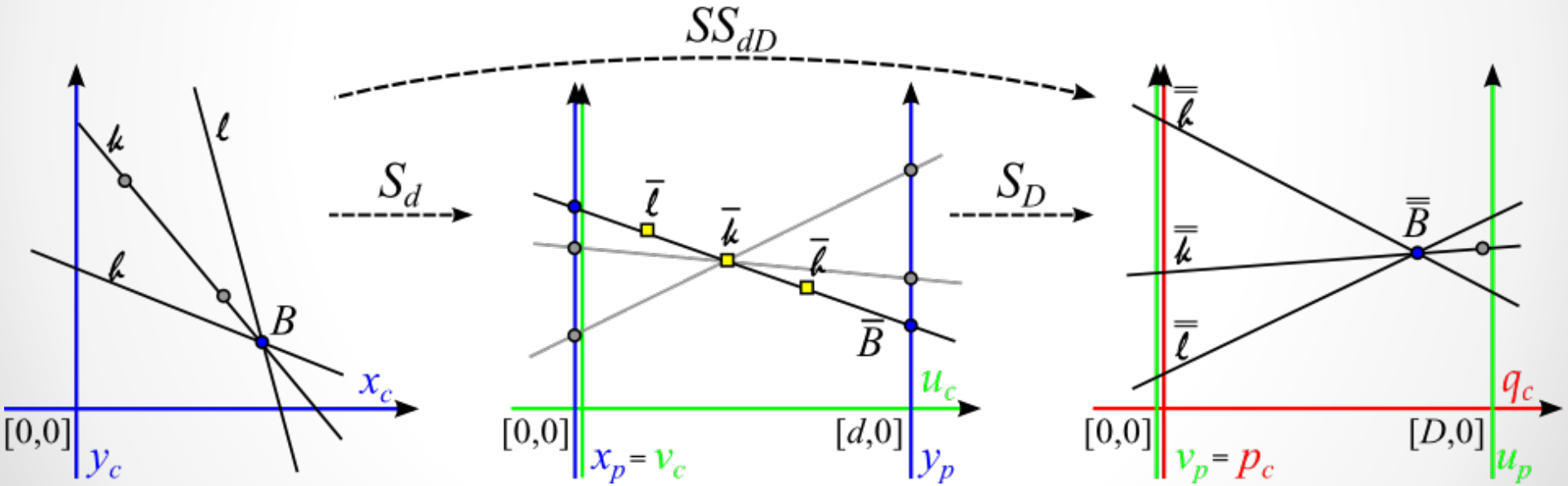


Dubska et al., PClines – line detection using parallel coordinates, CVPR 2011

Parallel Coordinates

- Cascaded Hough Transform (T. Tuytelaars et al.: The cascaded Hough transform, ICIP 1998)
- Regular point represented by a point
- Ideal point represented by a point



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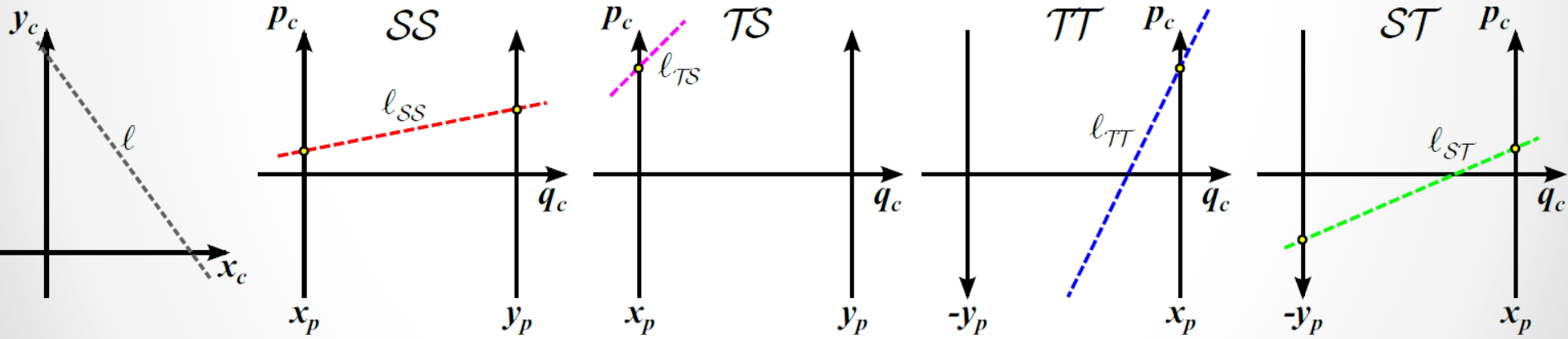
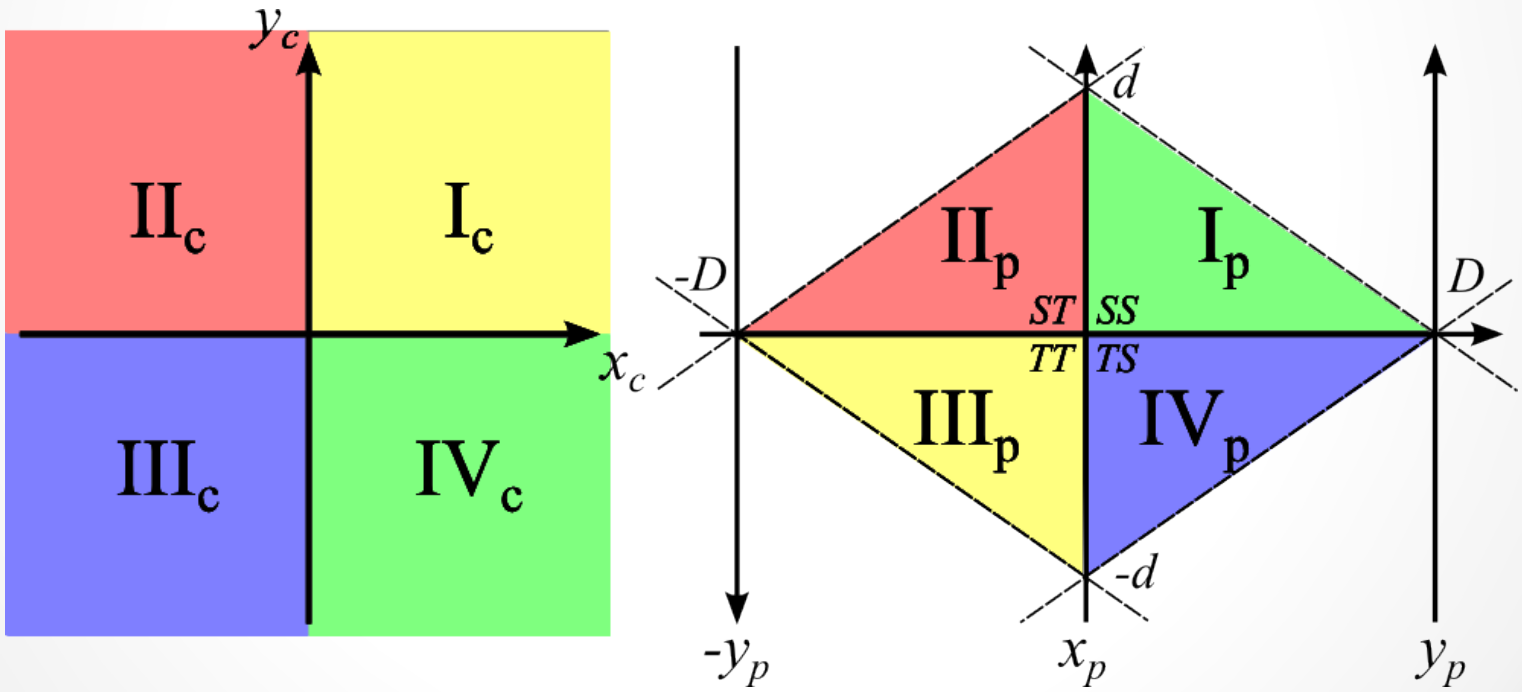


Diamond space

- Four different transformation (different axes arrangement)
- Four subspaces
- All points representations are **regular**



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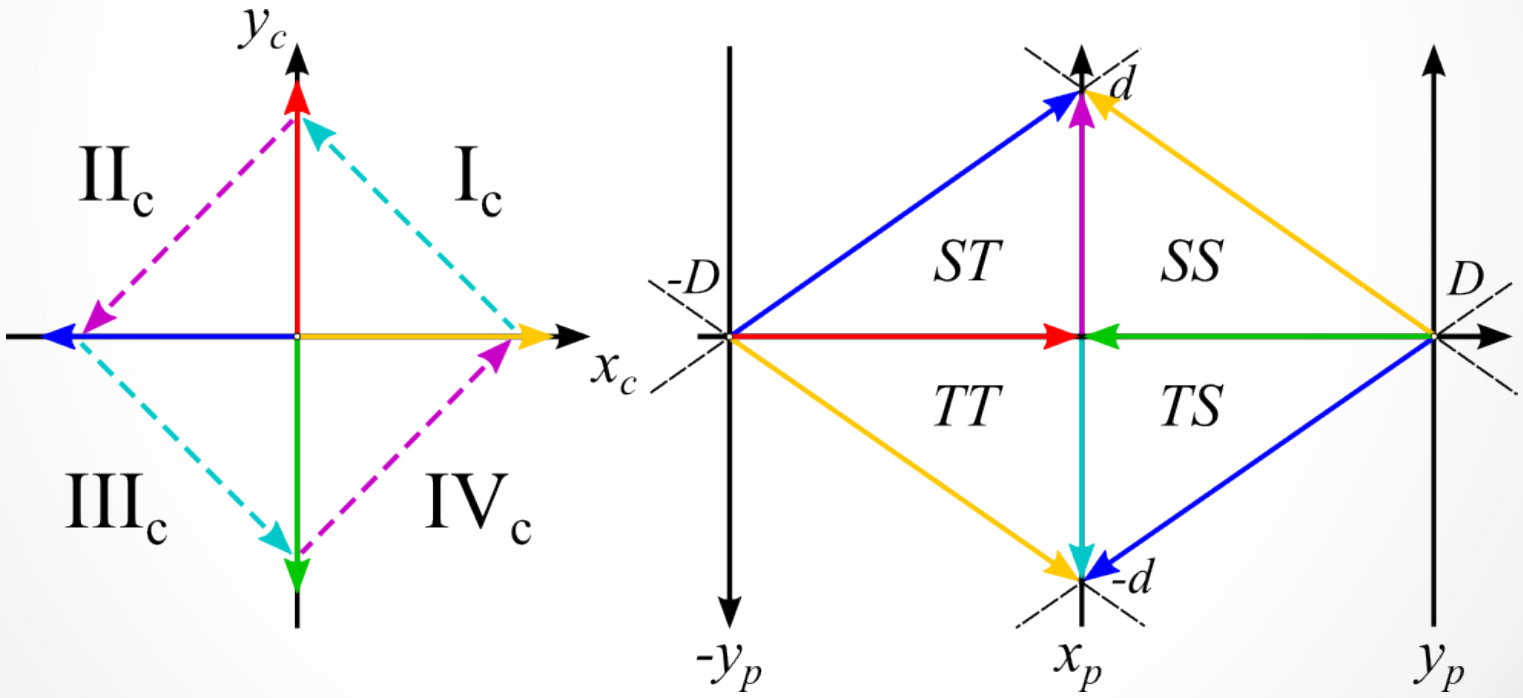

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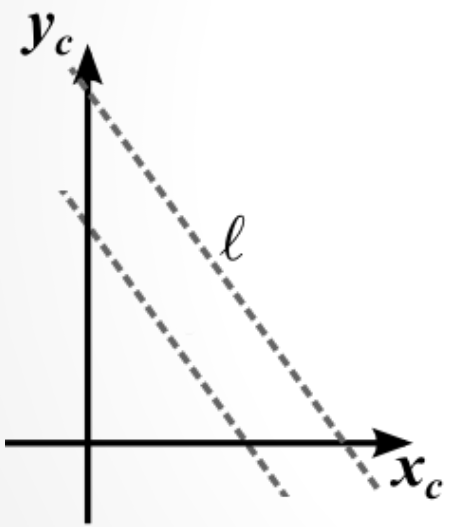
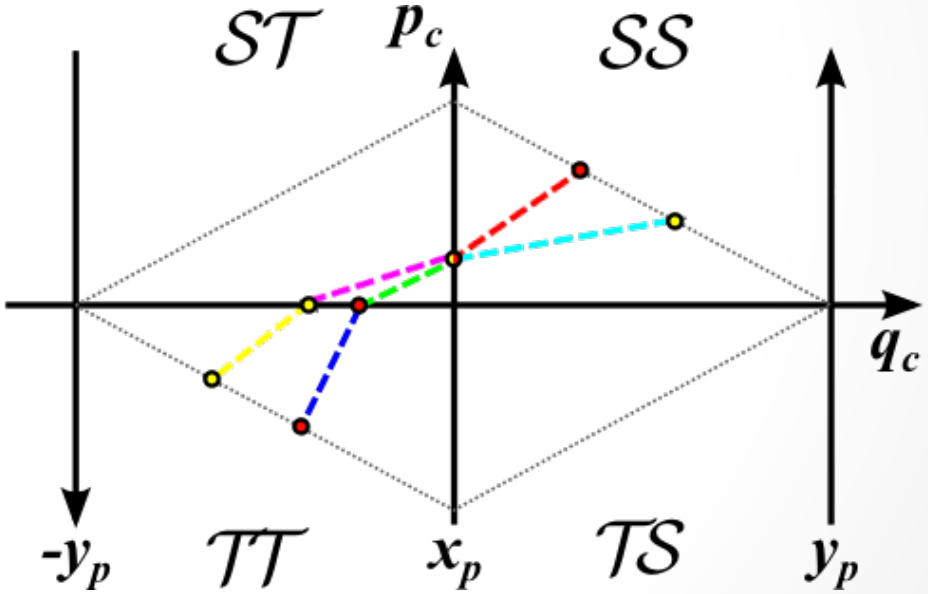




Algorithm

1. Manhattan image

Algorithm

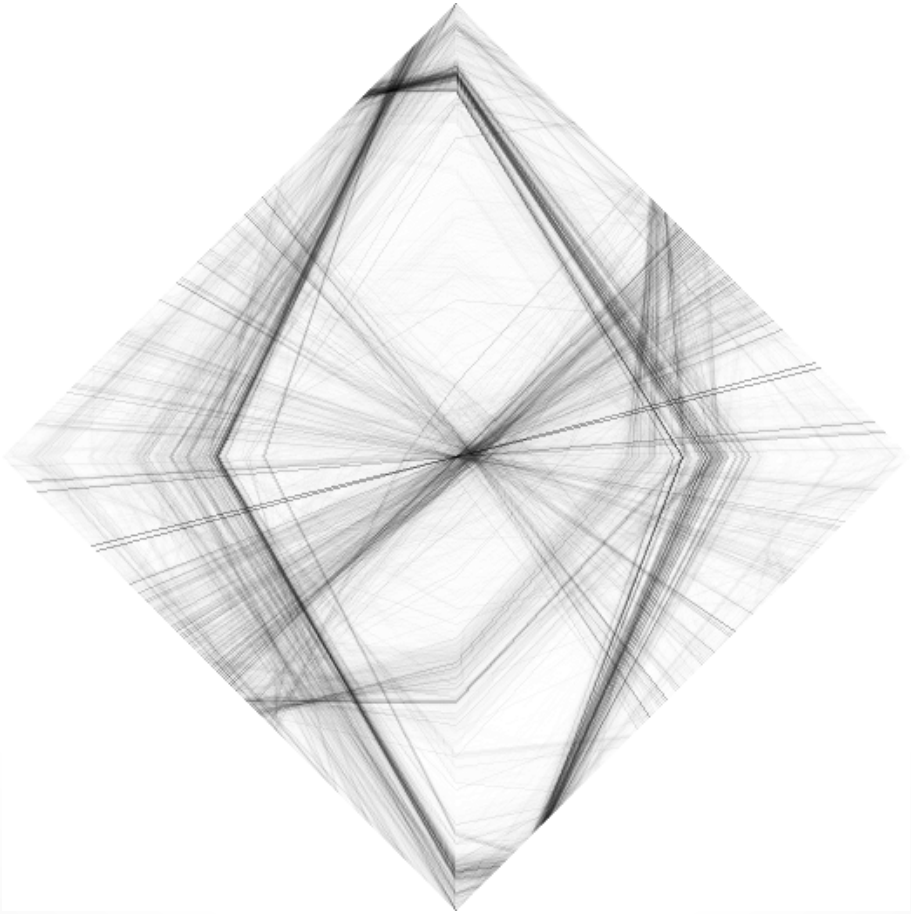
2. Edge points

Algorithm

3. Edgelets

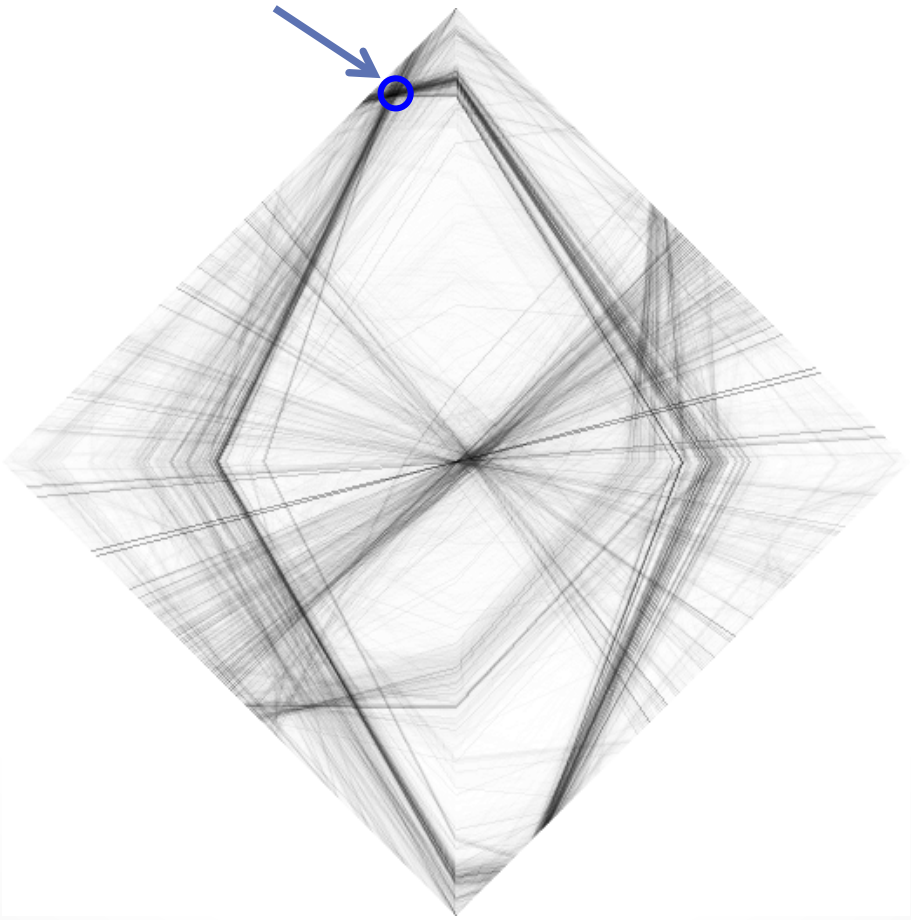
Algorithm

4. Accumulation



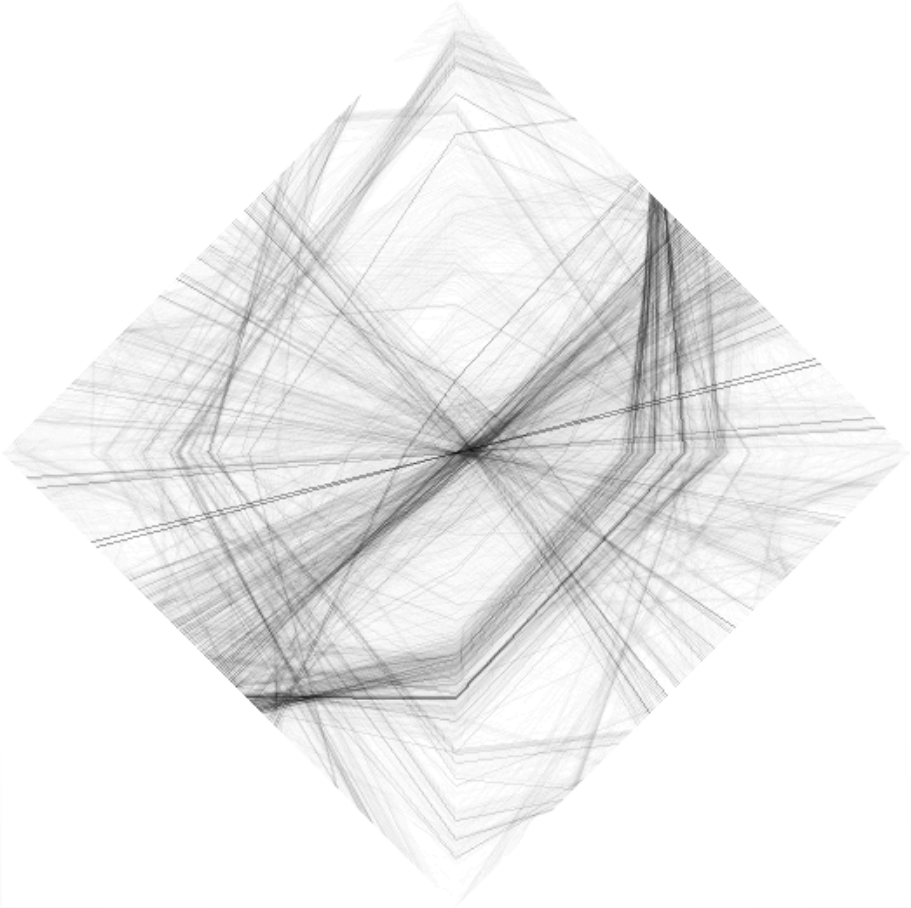
Algorithm

5. Search for maxima



Algorithm

6. Remove lines



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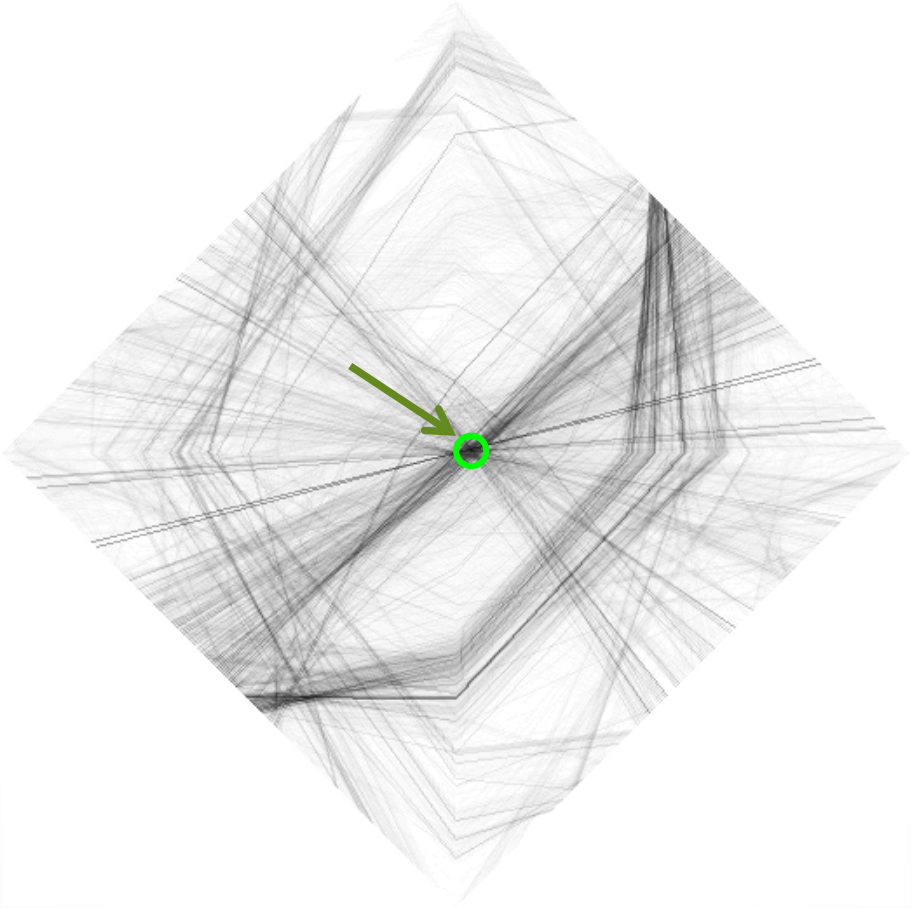
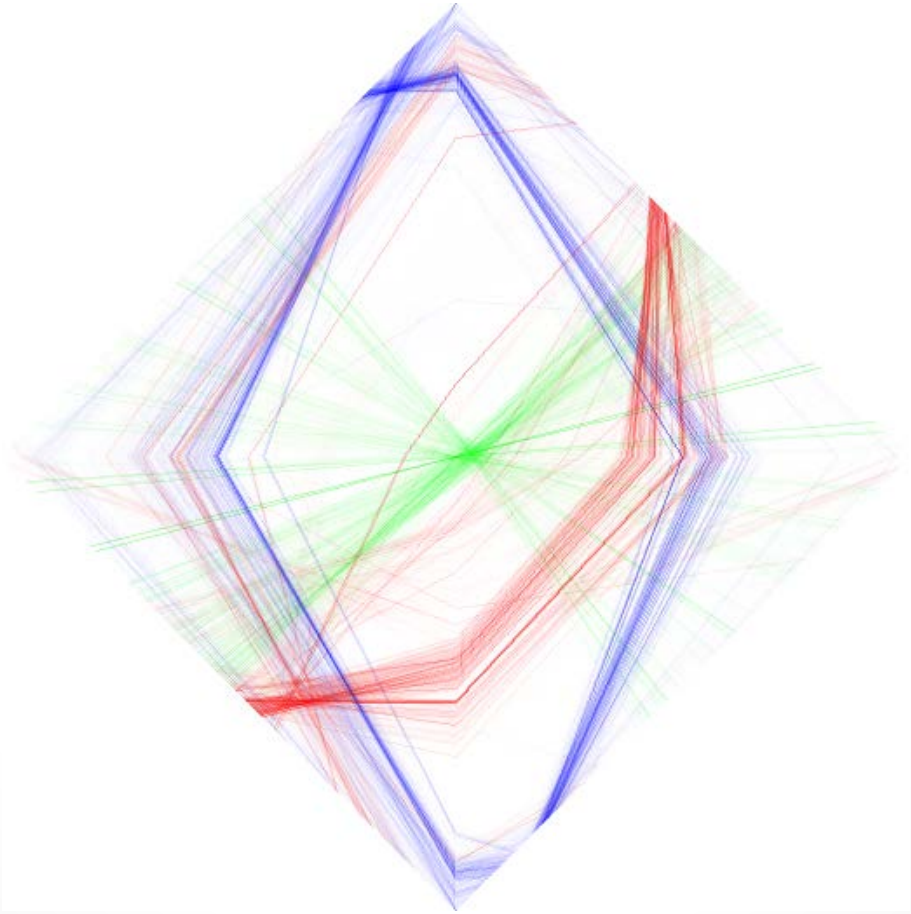


… repeat

Algorithm

7. Vanishing points with corresponding edgelets



Algorithm

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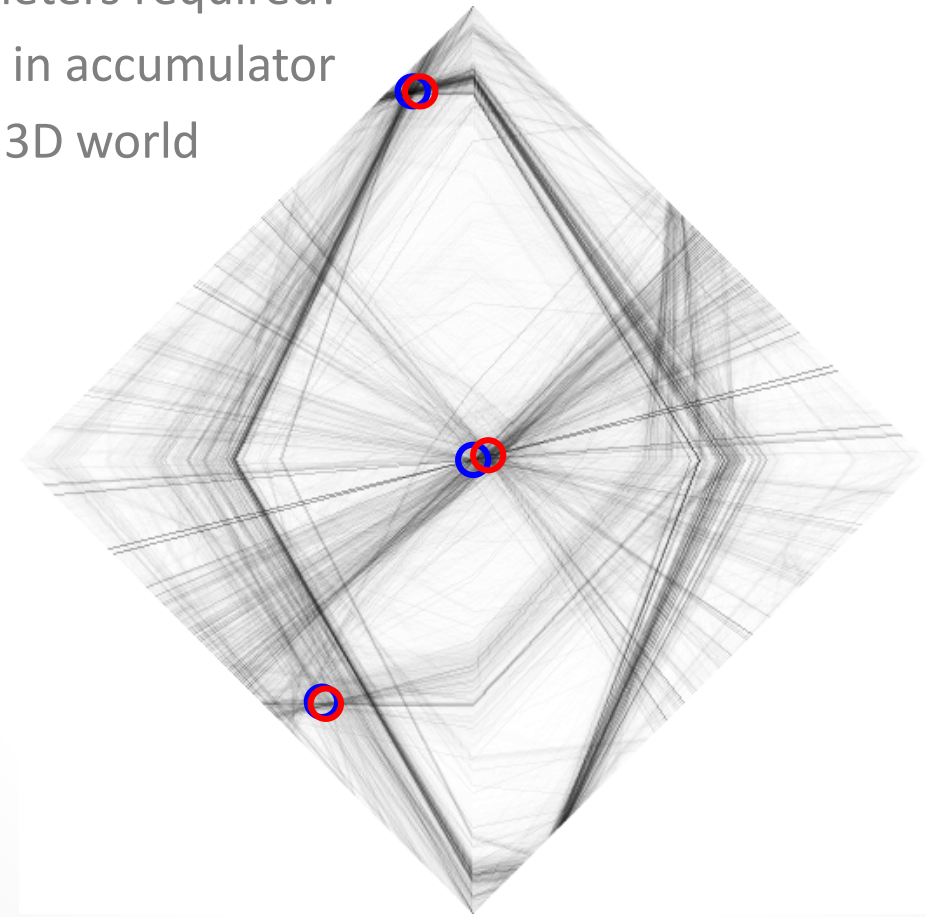
Algorithm

7. Orthogonalization

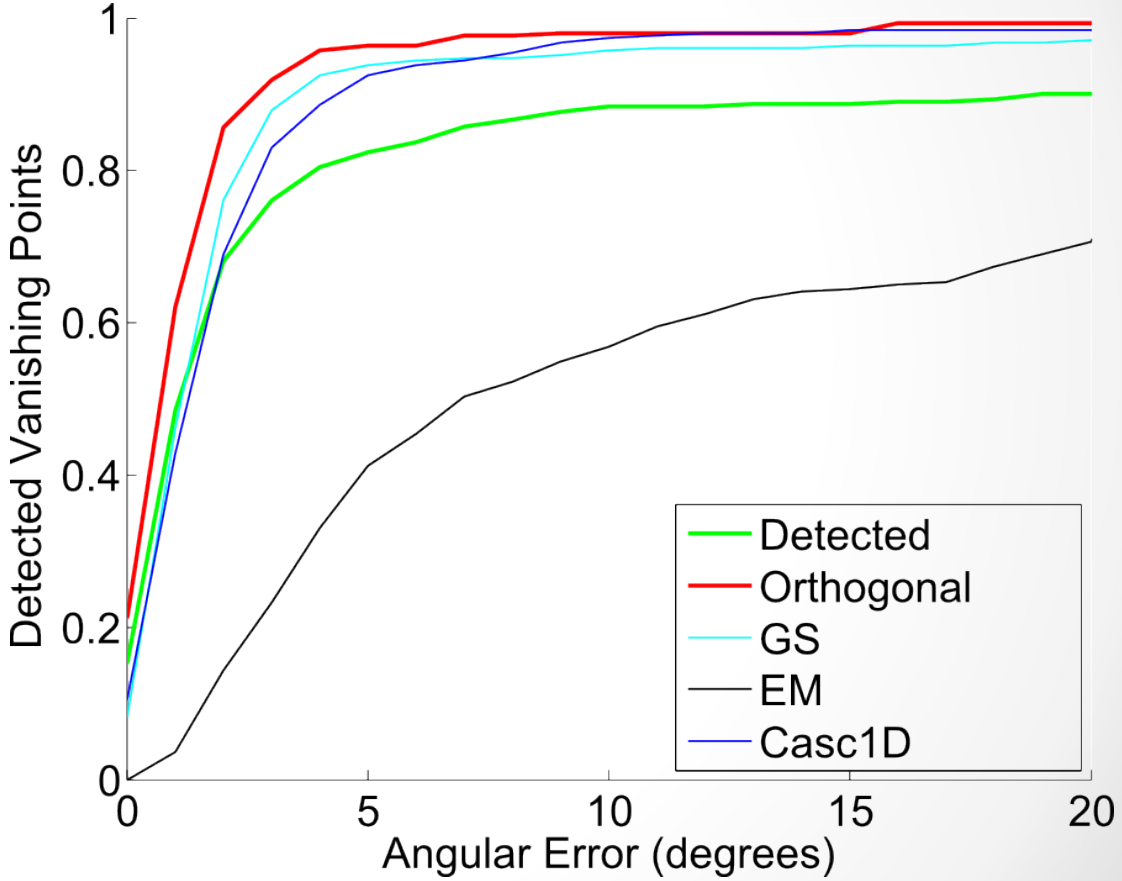
- camera parameters required!
- max response in accumulator
- orthogonal in 3D world



Results on YUD

98.04 % success rate at 10° angular error tolerance

with average error **1.41°**



[YUD] P. Denis: Efficient Edge-Based Methods for Estimating Manhattan Frames in Urban Imagery, 2008
[GS] S. T. Barnard: Interpreting perspective images, 1983
[EM] J. Košecká, W. Zhang: Video compass, 2002
[Casc1D] B. Li: Vanishing point detection using cascaded 1D hough transform from single images, 2012

Conclusion

Pros

- ideal/regular points mapped to regular points
- piecewise linear mapping
- simple accumulation and maxima search

Cons

- linear structures required
- dependent on edgelets detection

You can map infinite plane to a finite subspace using piecewise linear mapping

http://medusa.fit.vutbr.cz/pclines/