Camera Calibration using Vanishing Point Estimation

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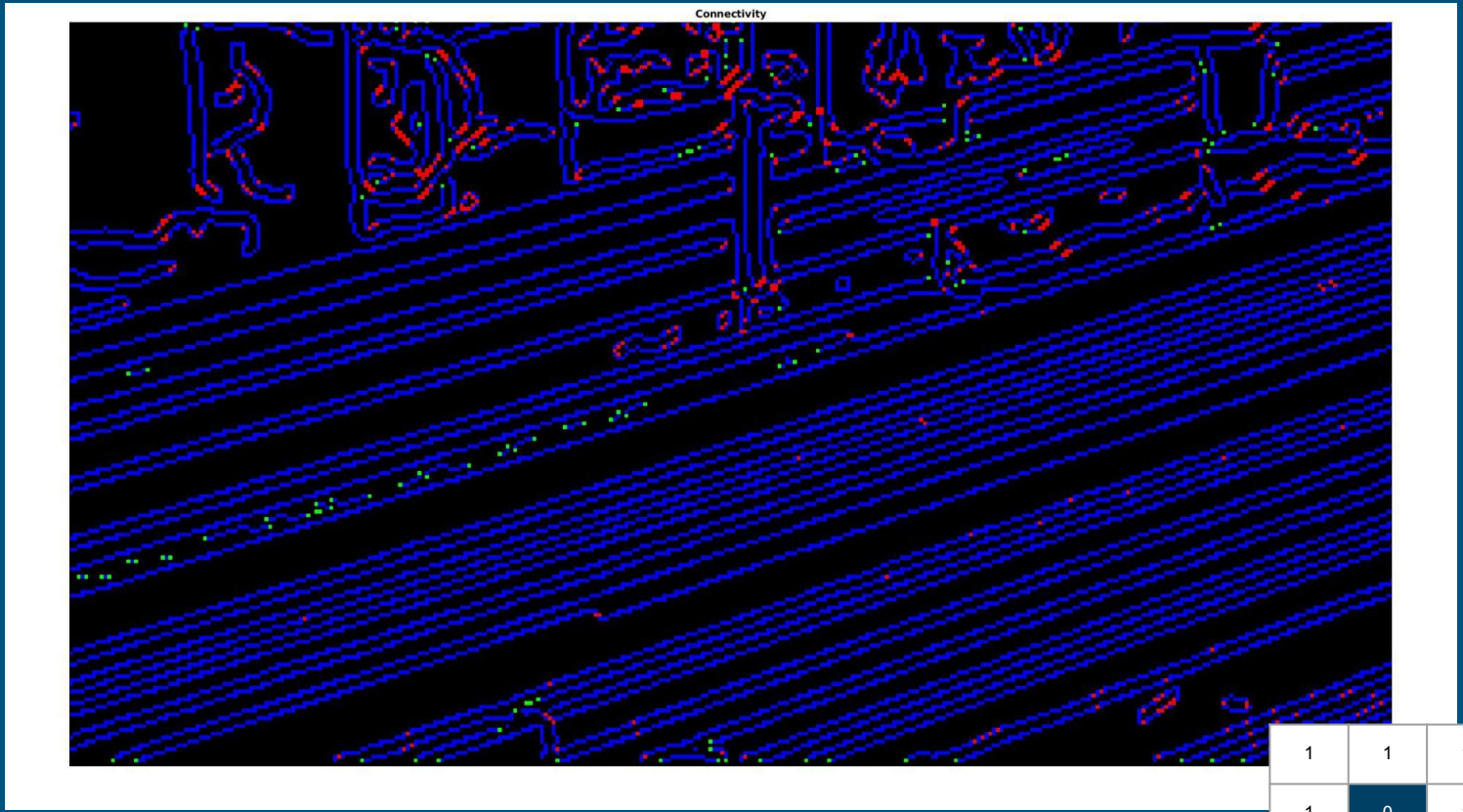
Overview

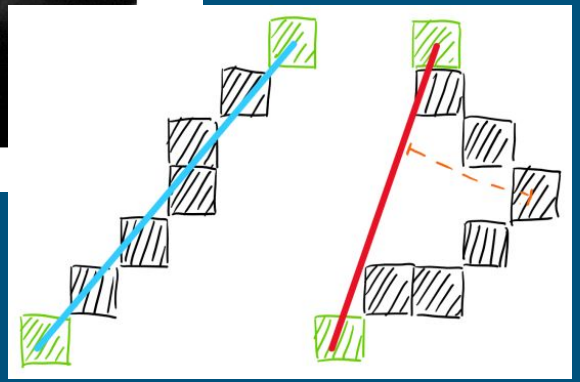
Segments detection	Edges classification	Calibration
From edge detection to selection of straight lines	Cluster the edges based on their compatibility with the hypothetical vanishing points	Extract the vanishing points on the Manhattan directions and calibrate

Segments detection



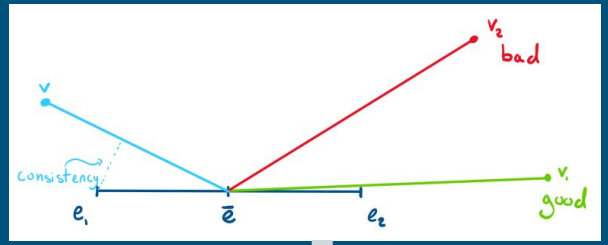
1	1	1
1	0	1
1	1	1

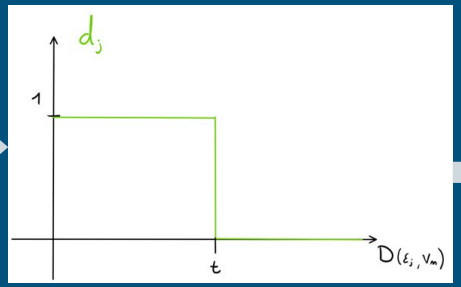
Edge detection and pixel classification

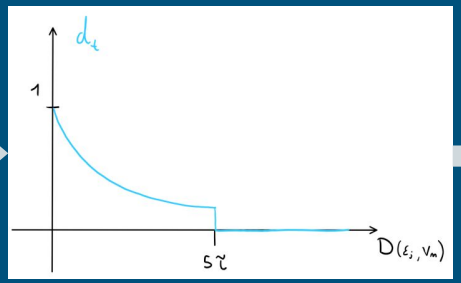


Straight lines detection

Edges classification

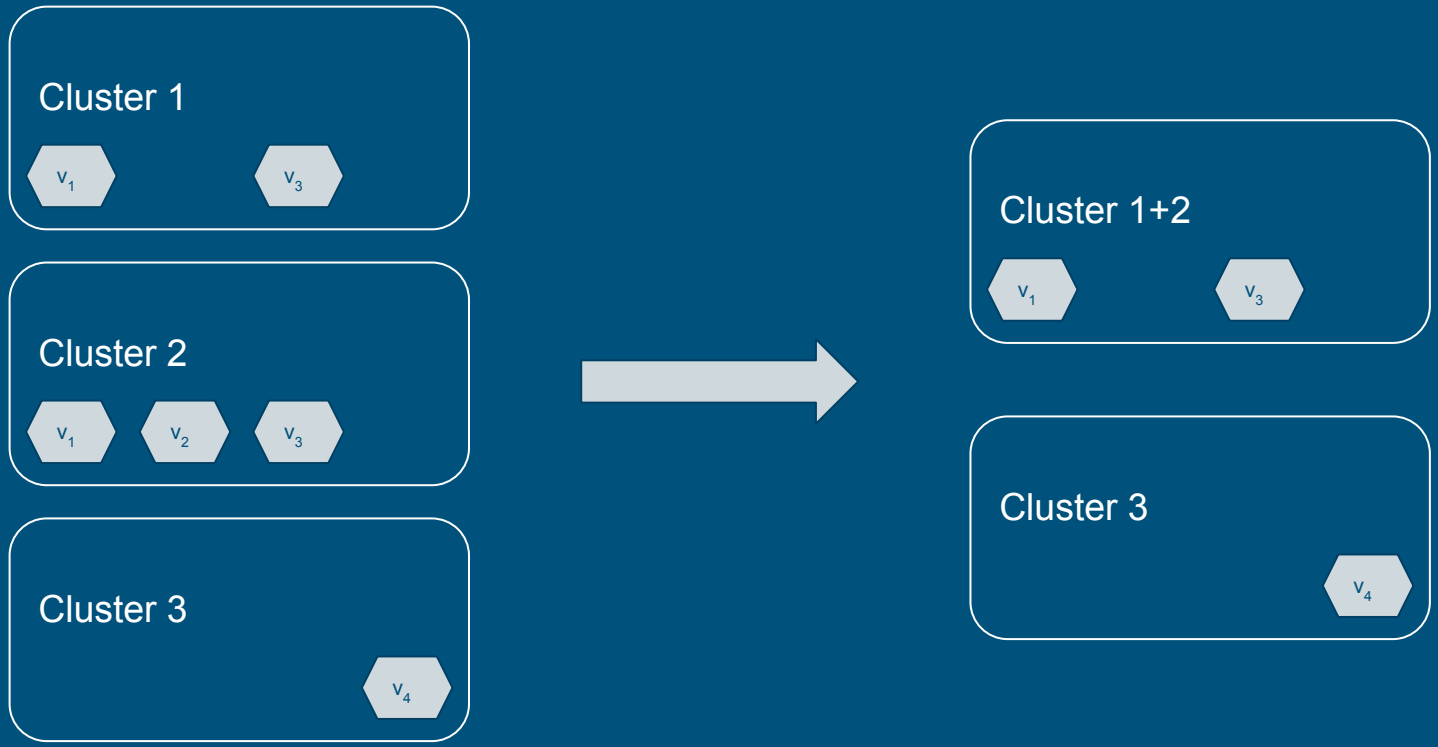




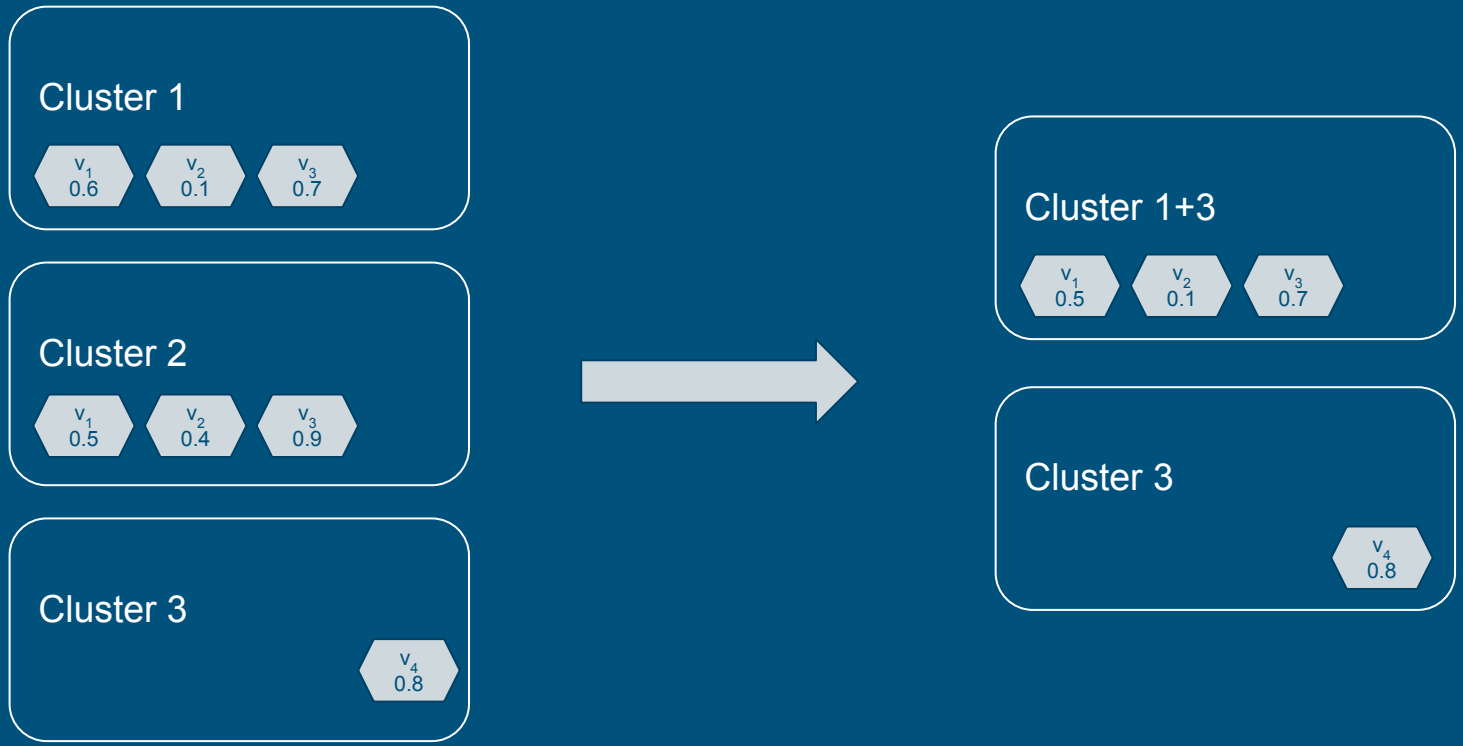


					hyp v_m			
edge ε_i					$d(\varepsilon_i, v_m)$			

Preference matrix



Clustering - Jaccard

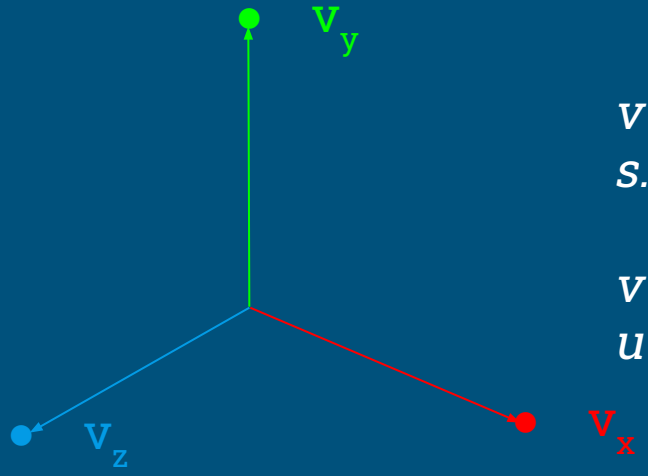


Clustering - Tanimoto

Calibration

$$\omega = (K K^T)^{-1}$$

$$K = \begin{bmatrix} f & 0 & u_0 \\ 0 & f & v_0 \\ 0 & 0 & 1 \end{bmatrix}$$



$v^T \omega u = 0 \qquad \forall \; v' \perp u'$
s.t.

v is the image of v'
u is the image of u'

Orthogonality constraints

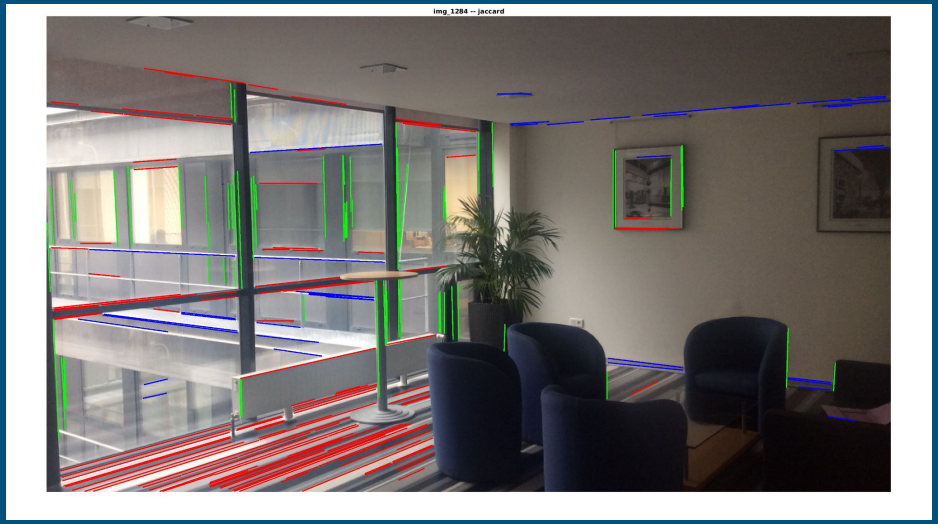
Assumptions:

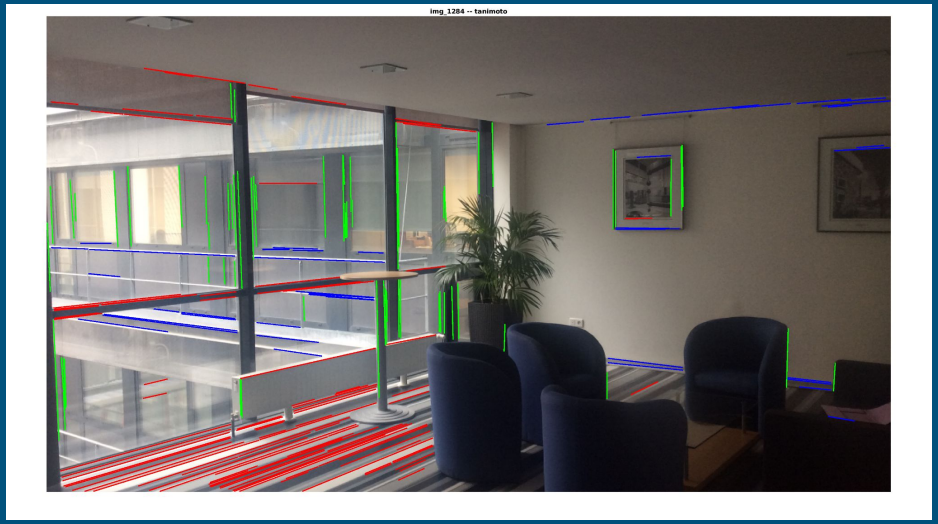
- $f_x = f_y = f$
- *no skew*

Results

Jaccard

Tanimoto





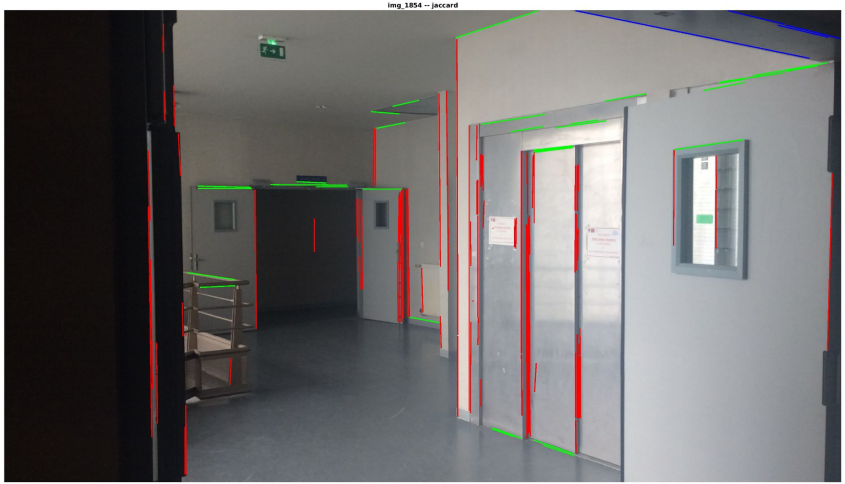
Classified edges

Jaccard

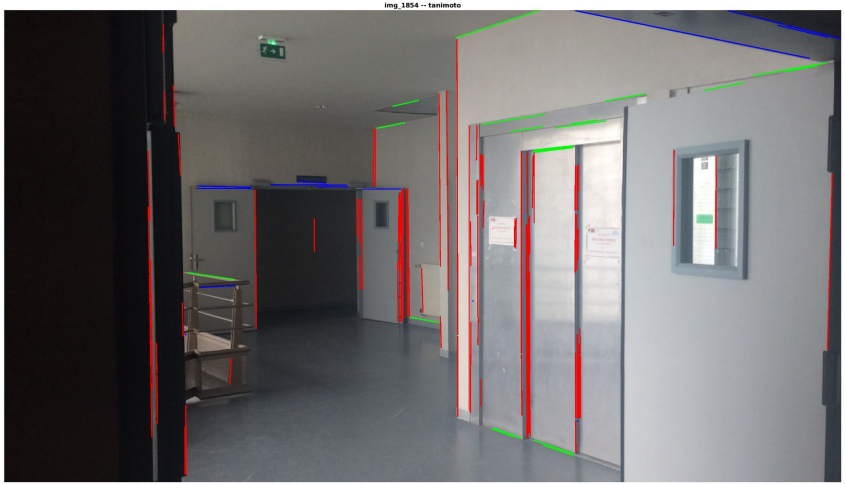
Tanimoto

Classified edges

Jaccard



Tanimoto



Classified edges

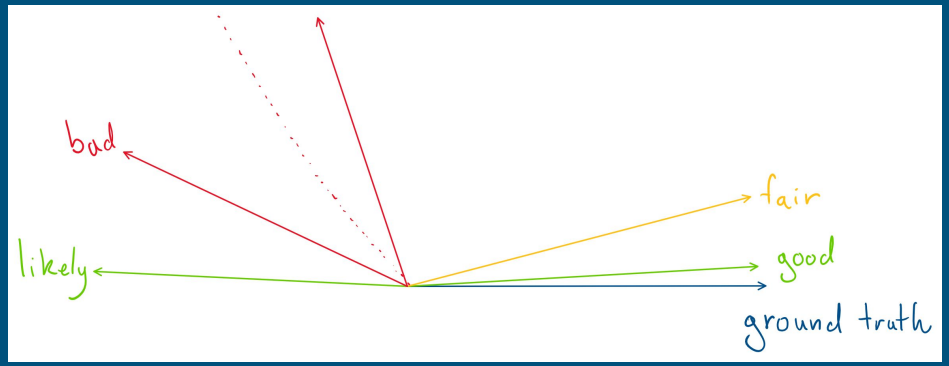
Vanishing Points quality assessment

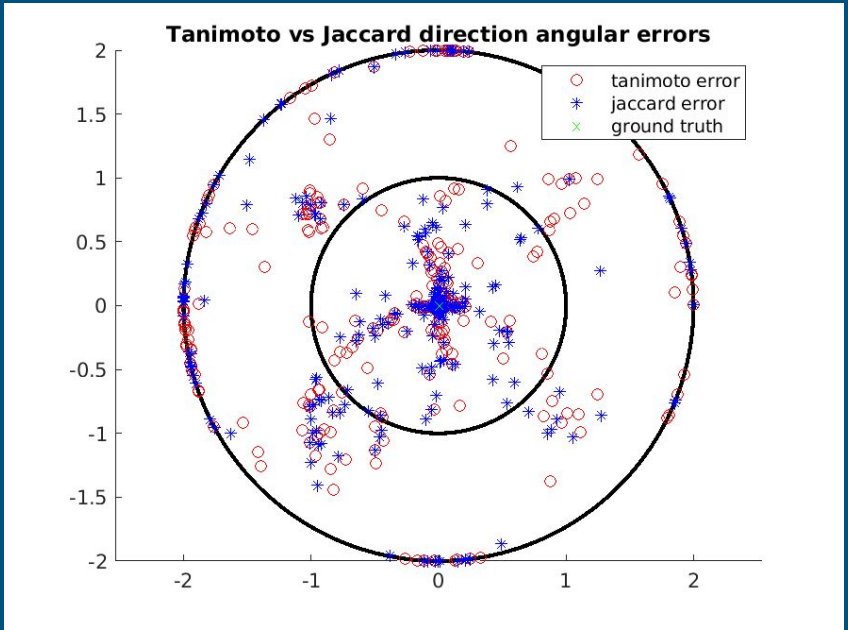
Problems

- The farther the VP, the more likely it is to get it wrong
- Associate our VPs with the ground truth ones correctly
- Slight errors in the lines' slopes can cause vanishing points to end on the opposite side of the image

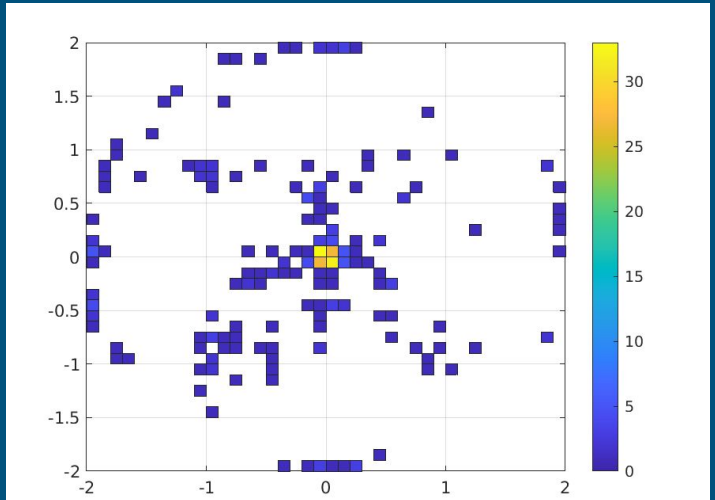
Solution

- Compare their directions

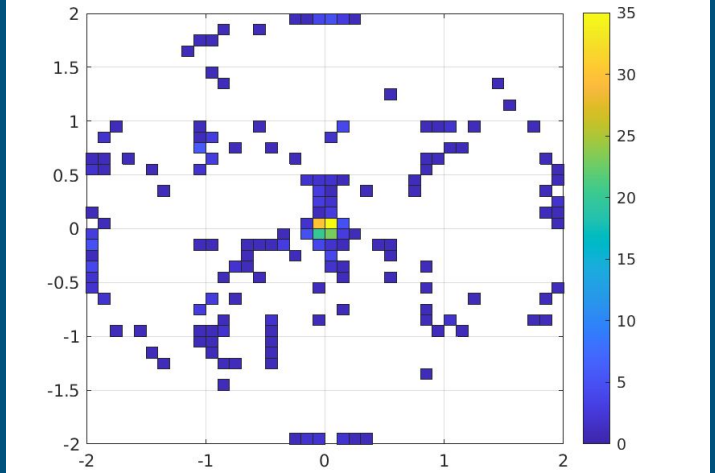




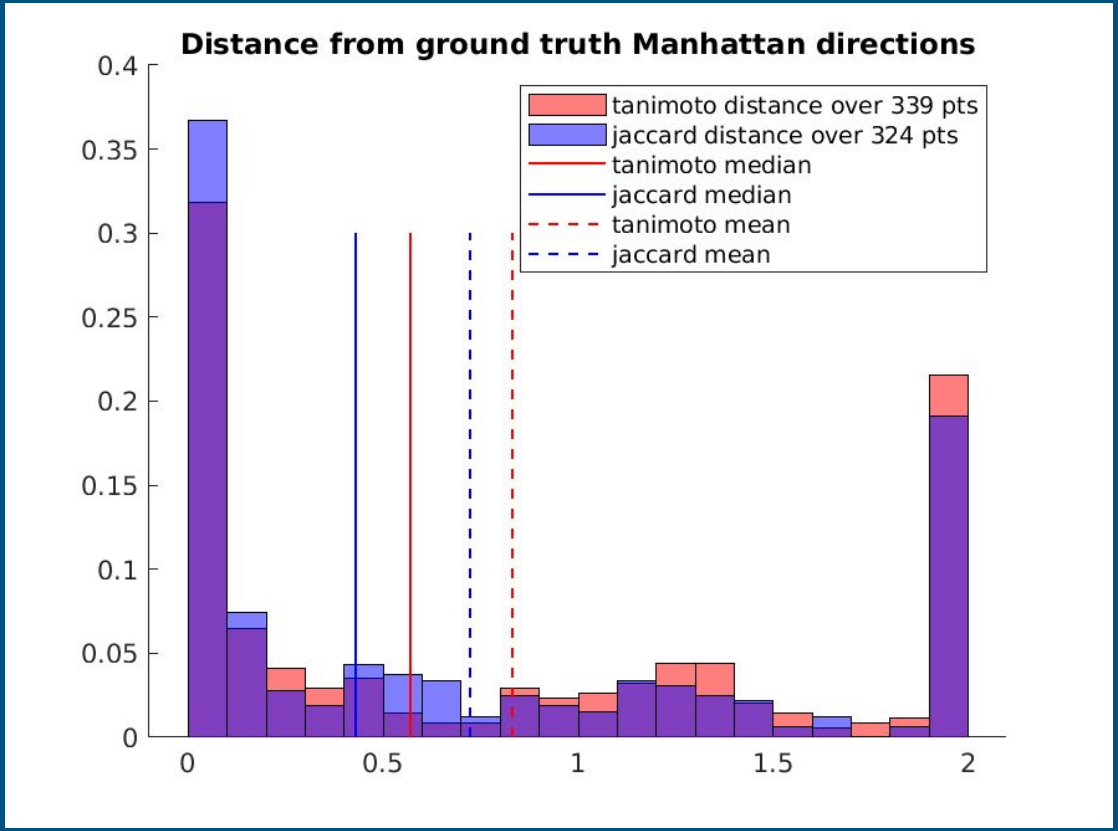
Jaccard



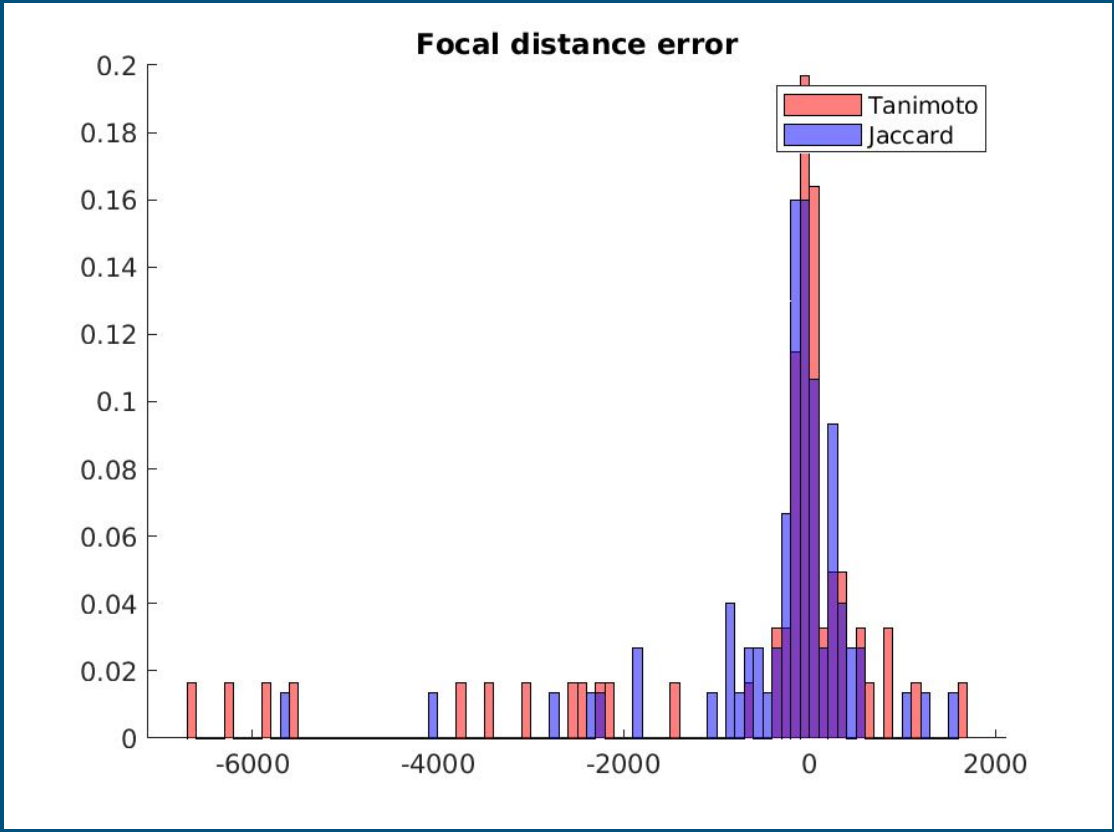
Tanimoto



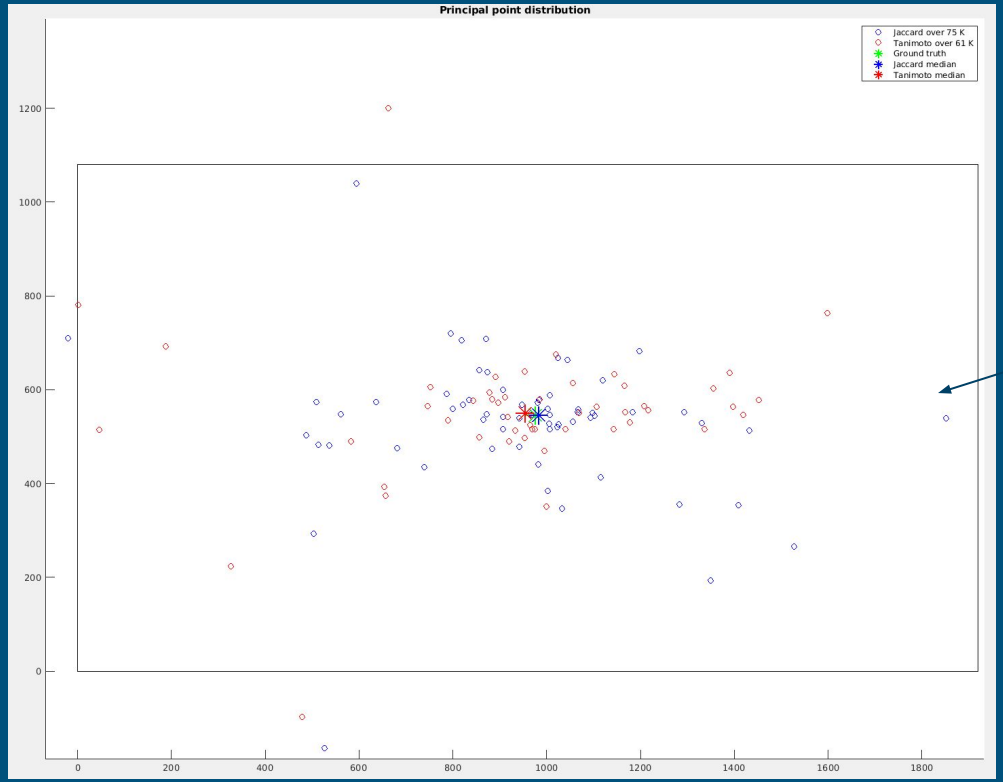
Angular errors of the vanishing points

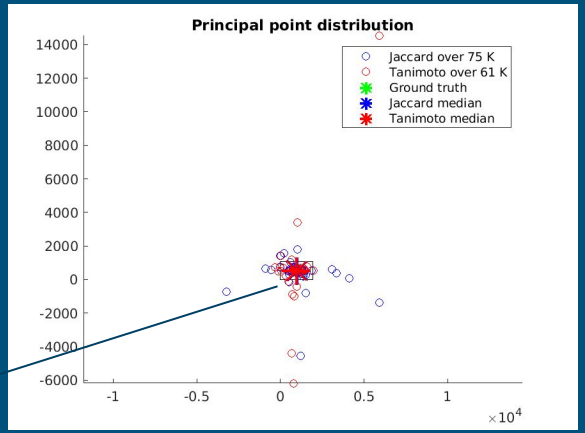


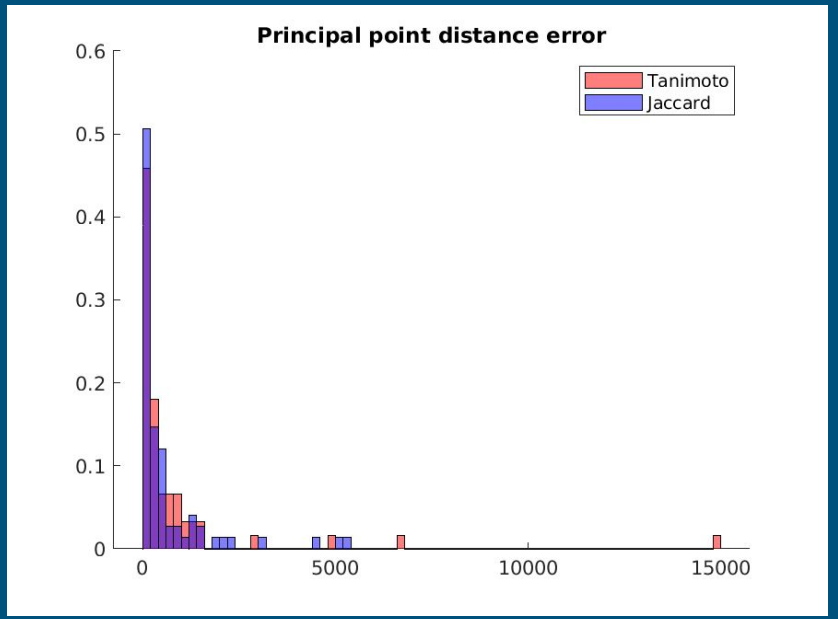
Vanishing points angular error distribution



Focal distance absolute error



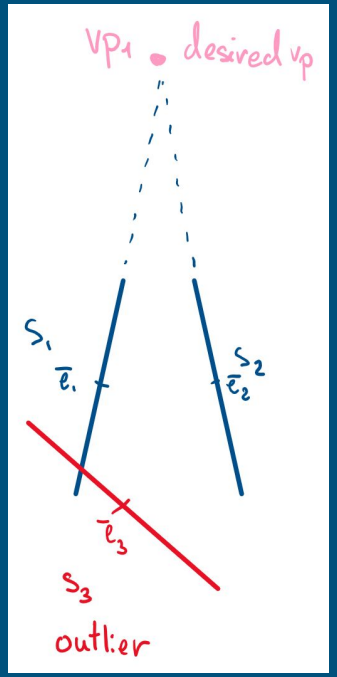


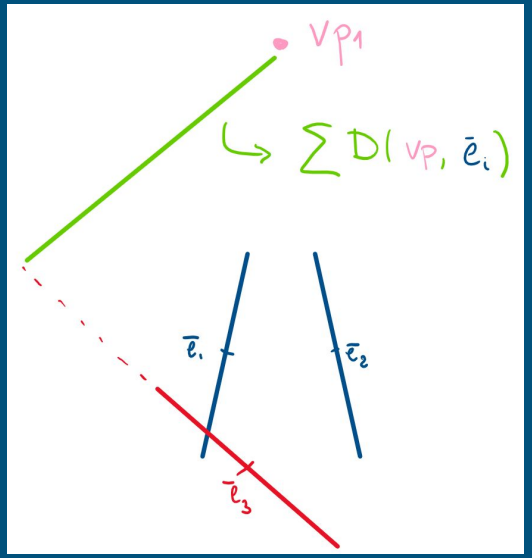


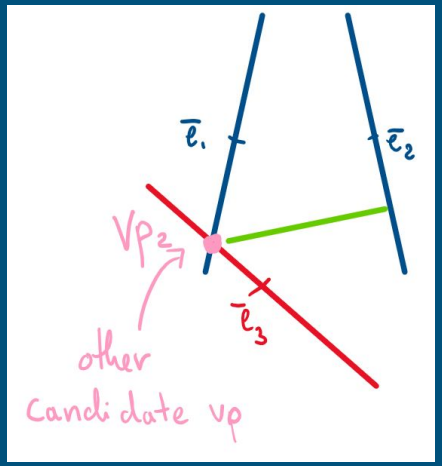
Principal points map

Possible improvements

- The cumulative consistency can suffer severely from outliers: replace function to find better vanishing points







Possible improvements

- Collinear edges' vanishing point is uninformative, and the same for very close lines. Solution: merge these.
- Not all the images had 3 vanishing points: improve segment detection
- Using Tanimoto didn't improve the results: improve the parameters