Left:Right Line Pairing

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Finding Left:Right Line Pairs

For all (left line, right line) pairs
- Reject if orientations not similar (vector dot < 0.9)
- Compute 3D overlap between 2 images (*)
- Reject short overlaps
- Recompute segment midpoints given overlap
- Compute contrast at midpoint (*)
- Reject pairs that do not have similar contrasts and suitable disparity range (*)

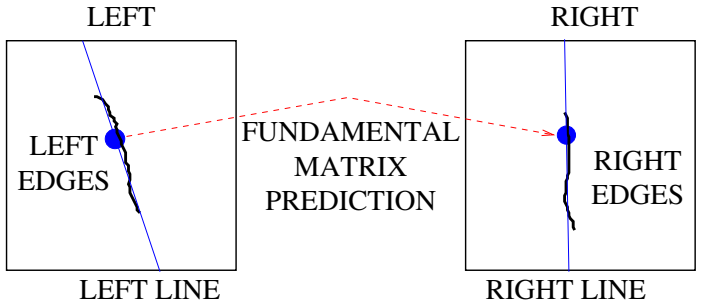
Remove pairs that are not unique

(*) - algorithm details below

Computing 3D Overlap I

Given: Paired lines (l,r) with midpoints ($\vec{m}_l, \vec{m}_r$) and directions ($\vec{a}_l, \vec{a}_r$)
Given: Fundamental matrix **F** that maps left to right image

Find corresponding edge points on 2 images that lie on the 2 lines:



Computing 3D Overlap II

1) Compute all points on left line that cross image:
$L = \{\vec{p}_\lambda : \text{for } \lambda = -\infty : \infty \text{ inimage}(\vec{p}_\lambda = \vec{m}_l + \lambda\vec{a}_l)\}$

2) Compute projective space representation of right image line:
If $\vec{a}_r = (a_{rx}, a_{ry})$, compute
$\vec{v} = (a_{ry}, -a_{rx}, -(a_{ry}, -a_{rx}) \cdot \vec{m}_r)$

$$\mathrm{M} = \begin{bmatrix} 0 & -v_z & v_y \\ v_z & 0 & -v_x \\ -v_y & v_x & 0 \end{bmatrix}$$

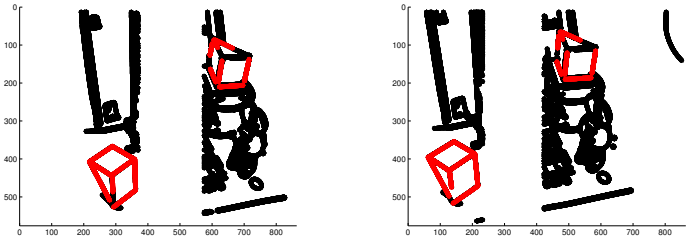
Computing 3D Overlap III

3) Predict corresponding point on right line that satisfies epipolar constraint for each point on left line:
for $\vec{p}_l \in L$ compute $\vec{q} = \mathrm{M} * \mathrm{F} * (\vec{p}_{lx}, \vec{p}_{ly}, 1)'$.
Then predicted pixel is: $\vec{p}_{r_l} = (q_x/q_z, q_y/q_z)'$

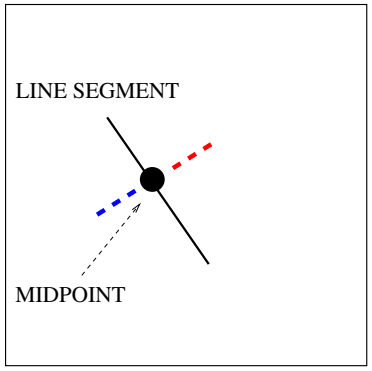
4) Corresponding points are valid if the $\vec{p}_l$ and $\vec{p}_{r_l}$ are both near (eg. $\leq \pm 4$ pixels) to a detected image edge.

5) Keep longest subset of consecutive valid edge points
Reject pairs if length is too small (eg. 55 points)
Recompute found segment midpoints

Used Edge Points

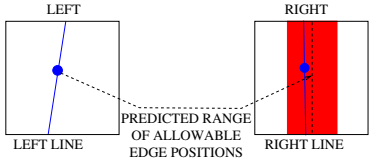


Computing Contrast



contrast = average(red pixels) - average(blue pixels)

Allowable Disparity Range



Left midpoint predicts allowable disparity shift of right midpoint

What We Have Learned

- Using the Fundamental matrix to link points in 2 images
- Several new 3D geometry methods