From Bows to Arrows: Rolling Shutter Rectification of Urban Scenes Vijay Rengarajan, A.N. Rajagopalan, and R. Aravind, Indian Institute of Technology Madras

apvijay.github.io/single rs rect

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Goal

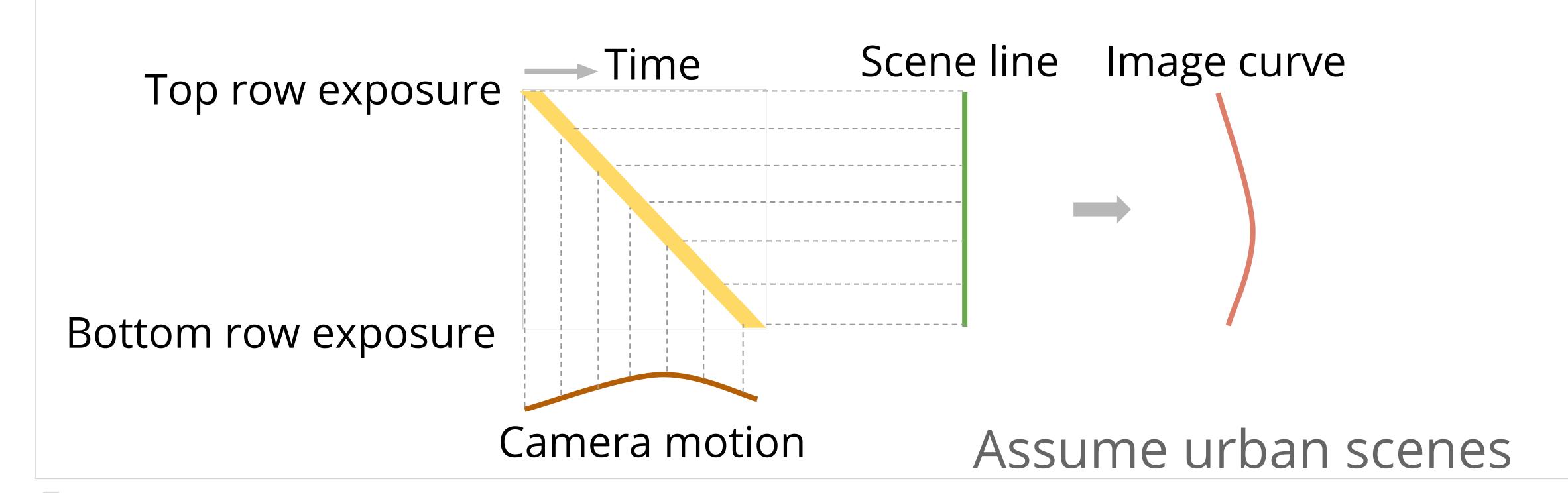
Correct rolling shutter distortions from a single image

Challenges

Lack of multiple images to exploit correspondences No motion blur to exploit local point spread functions How does one define distortions given only a single image?

Our idea

Exploit curves, which embed motion information



Camera motion model

Polynomial trajectory for rotations with respect to row index

For
$$i \in \{x, y, z\}$$
,

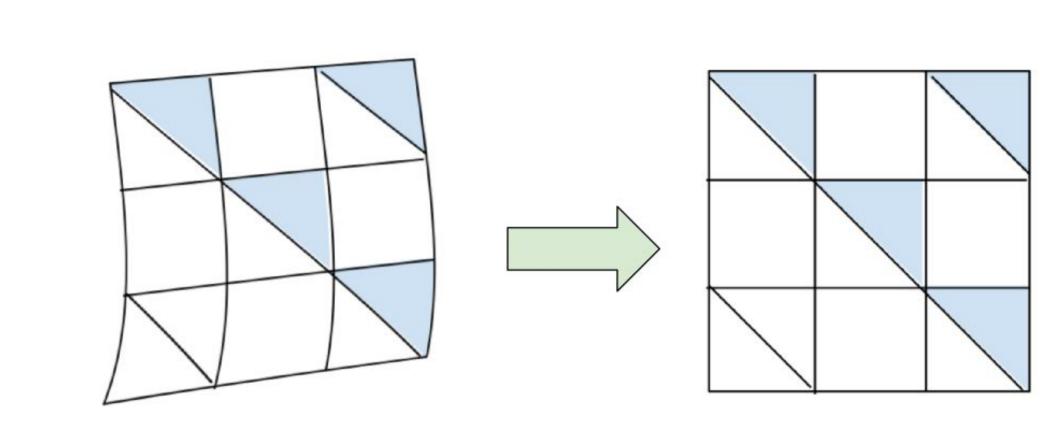
$$r_i(y) = \alpha_{i0} + \sum_{j=1}^{n} \alpha_{ij} \left(\frac{y-1}{M} \right)^j$$

 $y: \text{row index} \in [1, M]$ M: number of rows $\alpha_{ij}:j^{\mathrm{th}}\mathrm{coefficient}$ for the $i^{\mathrm{th}}\mathrm{axis}$ motion

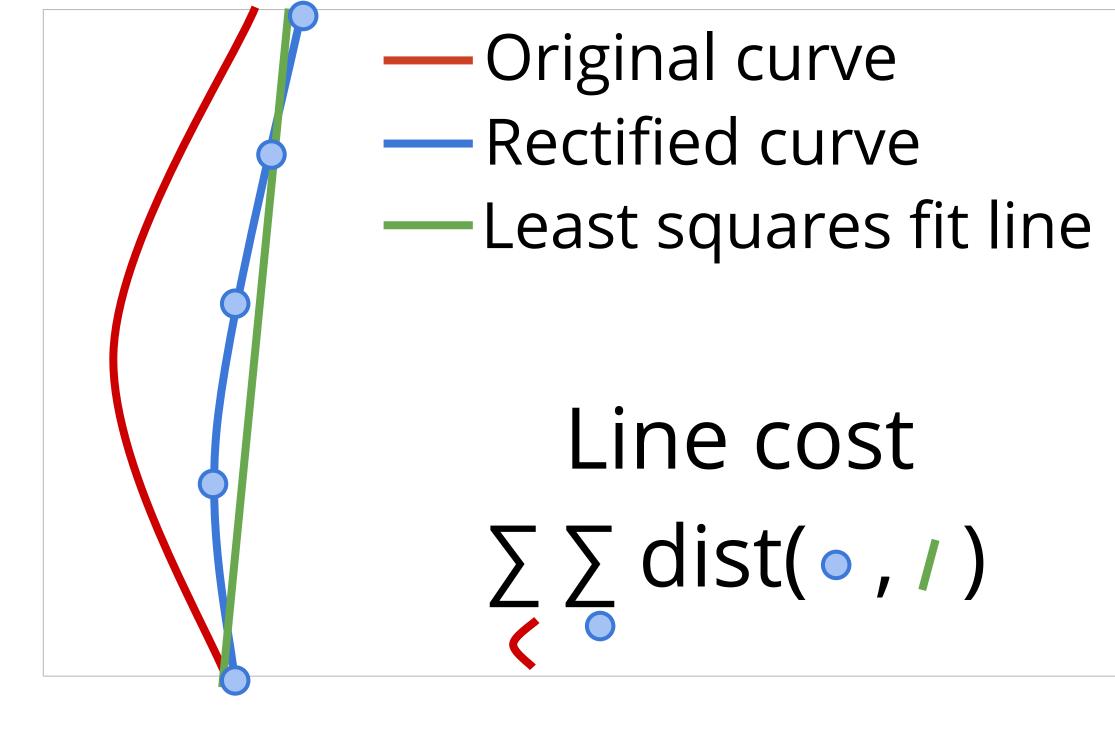
Approach

Develop a line cost based on straightness

curves to lines on inverse warping



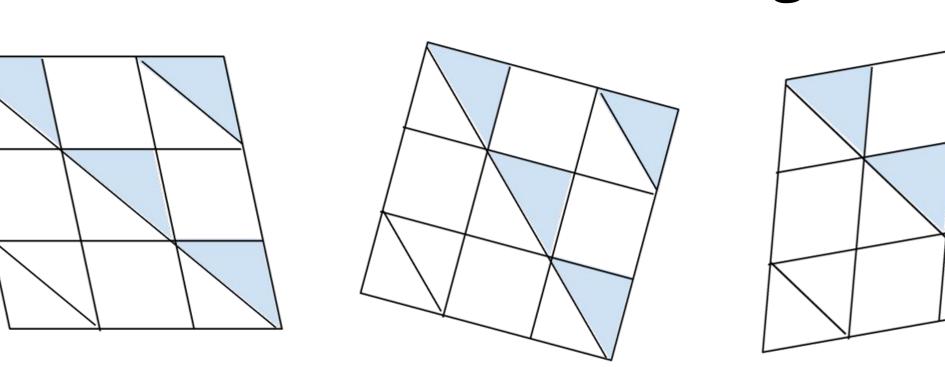
A desirable motion trajectory transforms Any other motion estimate will result in a non-zero line cost

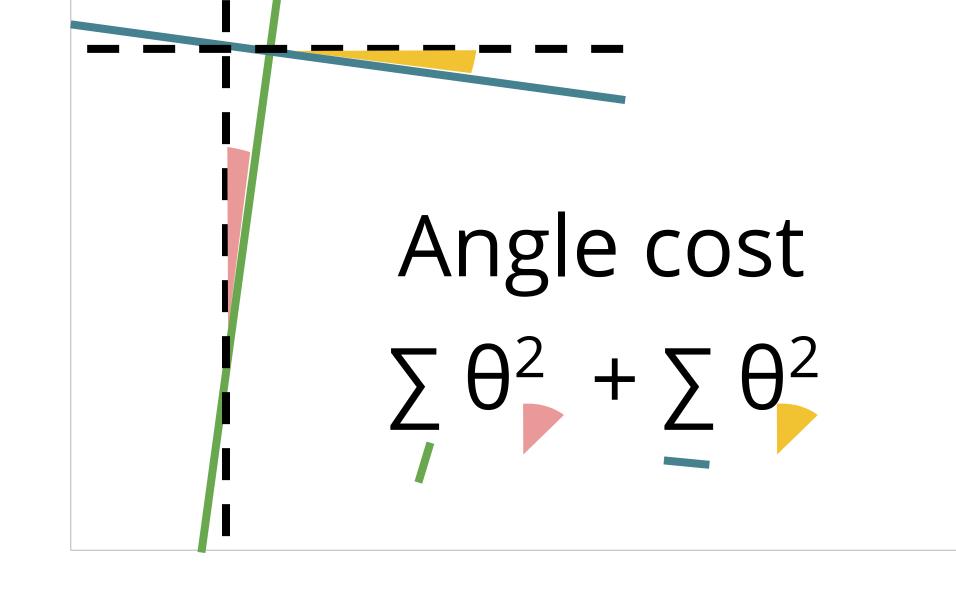


Geometric ambiguities due to row-wise motion

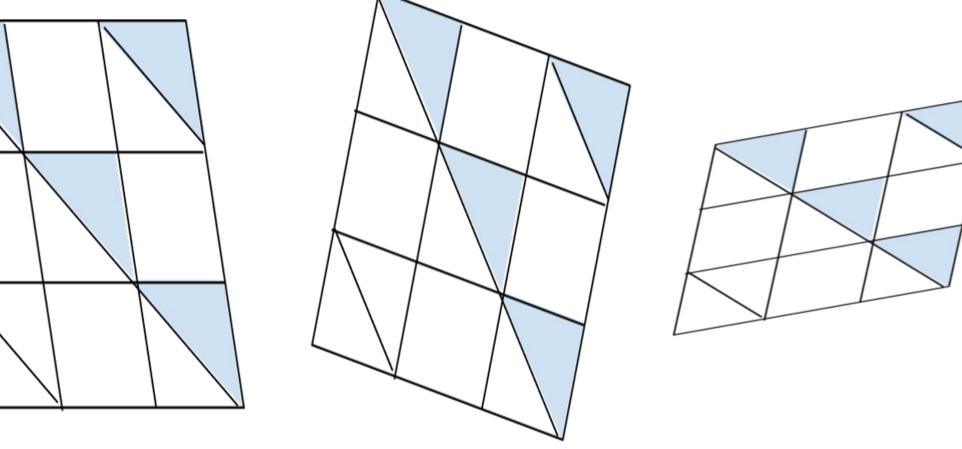
Develop angle and length desirability constraints

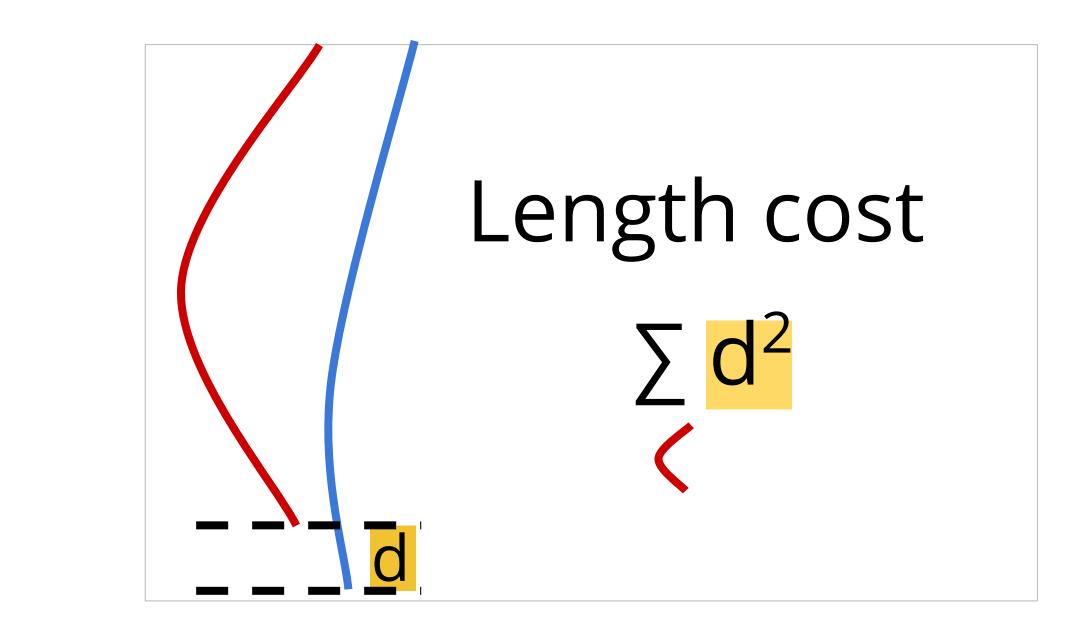
Skew and rotation ambiguities









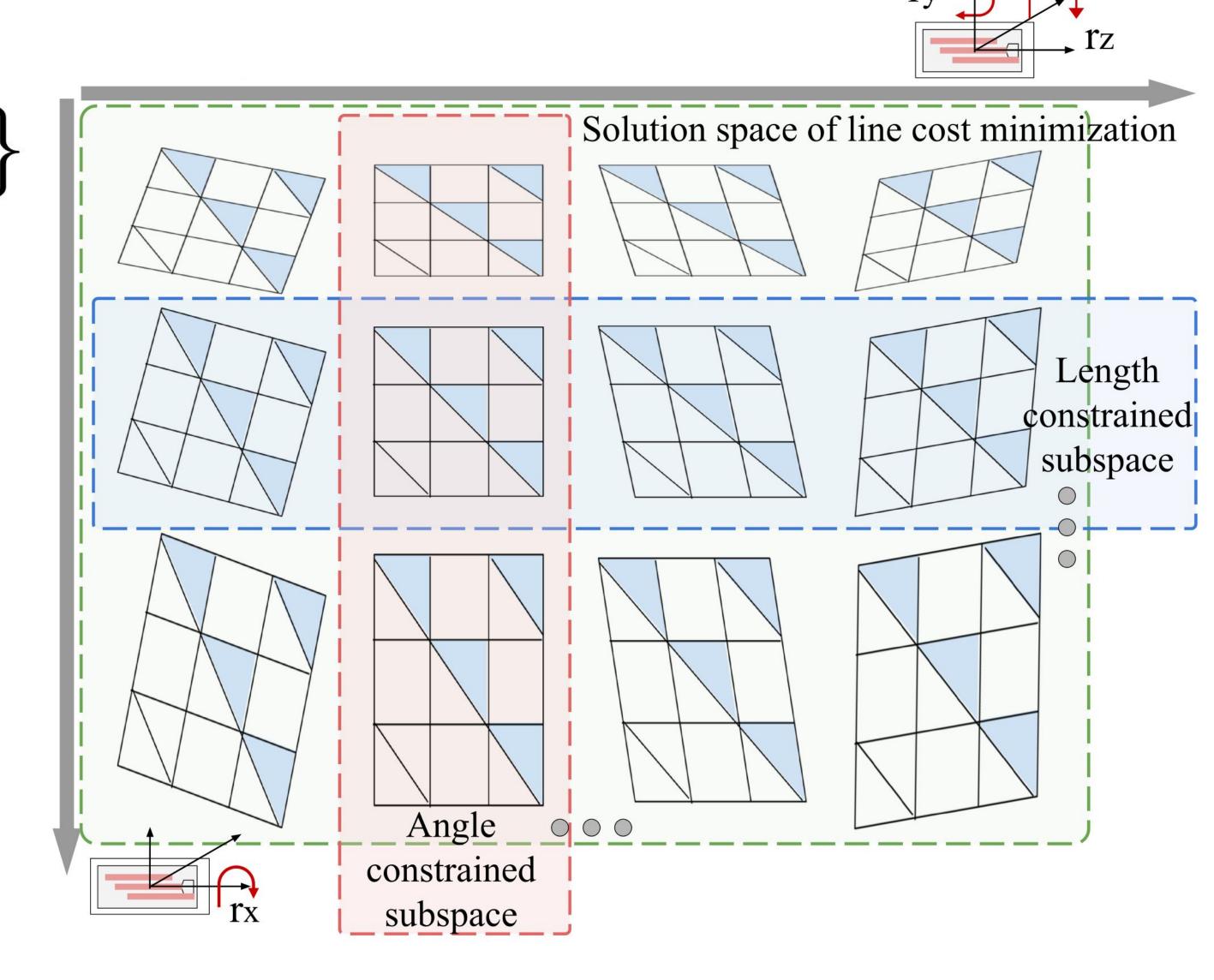


Optimization problem

Estimate polynomial coefficients of rotations that result in minimum line cost subject to desirability constraints

$$\{\widehat{\alpha}_{ij}\} = \arg\min_{\alpha_{ij}} \{ \text{ Line cost } \}$$

$$\text{subject to} \begin{cases} \text{Angle cost } < \epsilon_1 \\ \text{Length cost } < \epsilon_2 \end{cases}$$



Results

