To partition an image into polygons that capture the geometric structures contained in man-made environments.

KIPPI: KInetic Polygonal Partitioning of Images

Jean-Philippe Bauchet and Florent Lafarge

Inria – France

Motivations

- To offer more scalability and computational efficiency than traditional superpixel methods, e.g., [3], by reasoning at the scale of geometric shapes instead of pixels.
- To offer more flexibility on the shapes and the sizes of the polygons than current polygonal partitioning approaches [4,5], which return homogeneously-sized cells.

Goal

- Detection of line-segments [1]
- Regularization of line-segments
- Kinetic propagation

Problem statement

Our method

- We apply a set of local rotations $X = (x_1, x_2, \ldots, x_n)$ to the line-segments returned by [1] with respect to their centers. The vector $X$ is obtained by minimizing the energy

$$E(X) = (1 - \lambda) \mathcal{D}(X) + \lambda \mathcal{V}(X)$$

with $\mathcal{D}(X) = \frac{1}{n} \sum_{i=1}^{n} \left( x_i \right)^2$ and $\mathcal{V}(X) = \sum_{i=1}^{n} \sum_{j=i+1}^{n} \left| x_i - x_j \right| / 4 \theta_{\text{max}}$.

- $\mathcal{V}(X)$ encourages pairs of adjacent near-parallel or near-orthogonal segments to be exactly parallel or orthogonal while $\mathcal{D}(X)$ discourages high deviations from the original orientation of the line-segments.
- Minimizing $E(X)$ is a quadratic optimization problem with linear constraints.
- We then use an analogous formulation to translate adjacent parallel segments along their orthogonal axis, so that near-collinear segments get exactly collinear.

Kinetic propagation

A kinetic data structure [2] consists of:
- A set of geometric primitives whose coordinates are continuous functions of time,
- A set of certificates, which are properties that a kinetic data structure must satisfy at every time $t$ of the simulation, here a dynamic planar graph,
- A queue of events, defined as moments when such certificates get invalid and imply an update of the structure,
- A stopping condition, which tests whether the primitive should keep propagating after an event. The condition can be either gradient-based or a maximal number of intersections $K$.

References