Nonlinear Continuous Deformation of an Image Based on a Set of Intersecting Straight Lines

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Team common language
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References

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Abstract

Let I be a closed area within the plane, i.e., an image, which can be assumed to be a rectangle. Let D_i be a set of equidistant points belonging to a straight line and included in I. Let $A = \{D_i \mid i = 1, 2, \ldots, M\}$ be a collection of M straight lines. Some of the intersection points of lines in A may belong to I. Finally, let $g(x, y)$ be a function from the plane into itself representing a nonlinear, continuous and smooth deformation of I. Given $g(A)$, i.e., the image under g of the union of all the D_i, the problem is to find a method for estimating g.

The function g to be estimated represents the nonlinear image deformation produced by the lens of a camera. There are several simple models of this deformation (see references nos. 3 and 4 above). We are looking, however, for a solution independent of the lens type, although certain assumptions may be made. In general, the points belonging to a given straight line will be neither colinear, nor equidistant, after having been "transformed" by g. One may retain the assumption that the points belonging to a straight line D_i will belong to a convex segment after their transformation. One may also assume that g is radially symmetric with respect to a point that is not known a priori. Note that the original coordinates of the points are unknown; only the incidence relation between points and lines is known.

The difficulty lies in trying to control the behaviour of the function g near the points where two lines D_i and D_j intersect, or, more precisely, near a pair of points close to one another but that do not belong to the same

line. The naive approach consists in estimating the deformation separately for each line; this approach can produce a solution that is not consistent near the intersection points. For the same reason, computing the average of the deformations does not yield a valid solution in general. Our suggestion is to define a cost measure, for instance an elastic energy, to constrain the function g.