Improved Splitting-Integrating Methods for Image Geometric Transformations

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Abstract

The splitting-integrating method(SIM) is well suited to the inverse transformations of digital images and patterns in 2D, but it encounters some difficulties involving nonlinear solutions for the forward transformation. New techniques are explored in this paper to bypass the nonlinear solution process completely, to save CPU time, and to be more flexible for general and complicated transformations T. The greyness of images under geometric transformations by the splitting-integrating method has the error bounds, $O(H) + O(H/N^2)$ as the piecewise bilinear interpolations ($\mu = 1$), for smooth images, where $H(<< 1)$ is the mesh resolution of an optical scanner, and N is the division number of a pixel split into N^2 sub-pixels. Moreover, there often occur in practical applications the discontinuity images whose greyness jump is a minor portion of the entire image, e.g., the piecewise continuous images but with the interior and exterior boundary of greyness jumps, or the continuous pictures accompanied with a finite number of isolated pixels. For this kind of discontinuous images, the error bounds are also derived in this paper to be $O(H^\beta) + O(H^\beta/N^2)$, $\beta \in (0, 1]$ as $\mu = 1$. Compared with the error analysis in our previous papers where the image greyness is always assumed to be smooth enough, this error analysis is significant for geometric image transformations.

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