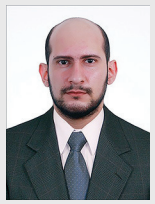
Image Shock Filtering With Mimetic Differences



Shock filters are crucial tools in image processing, especially for enhancing edge features in images, which play a vital role in fields such as medical imaging, astronomy, and photography. This work explores the implementation of a shock filter using mimetic differences, focusing on its application to image deblurring and edge detection. Shock filters utilize partial differential equations (PDEs) to sharpen image details by highlighting edges and reducing blur. A key aspect of their functionality is the detection of singularities and edge amplification, often achieved through nonlinear operators. The mimetic scheme ensures that the discretized form of the shock filter maintains the essential properties of the underlying PDE. Preprocessing steps, including pixel normalization and grayscale conversion, are essential for consistent results. Additionally, the work covers implementation details, such as the use of gradient operators and numerical solutions to achieve image enhancement. Performance is evaluated using metrics like the Mean Structural Similarity Index (MSSI) and Peak Signal-to-Noise Ratio (PSNR).

Juan S. Carrillo *and Miguel Dumett*

This research is supported by the Department of Mathematics & Statistics at San Diego State University and the Computational Science Research Center (CSRC) at San Diego State University

Initial Condition

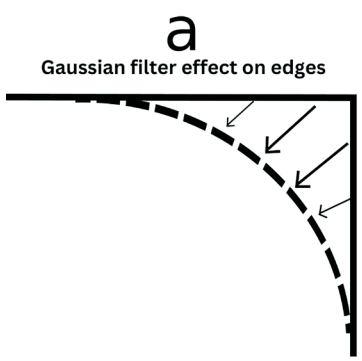
Shock Filter Application

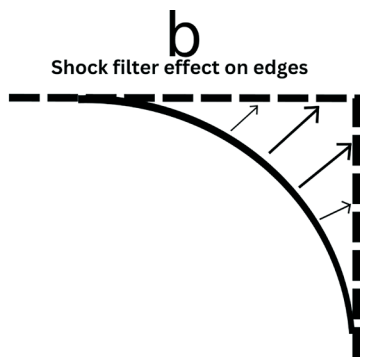
Image Shock Filtering Equation

$$u_t = -\left|\nabla u\right| F(\mathcal{L}(u))$$

$$F(x) = \begin{cases} 1 & if\ x > 0 \\ 0 & if\ x = 0 \\ -1 & if\ x < 0 \end{cases}$$

$$\mathcal{L}(u) = \nabla u \cdot \begin{bmatrix} u_{xx} & u_{xy} \\ u_{yx} & u_{yy} \end{bmatrix} \nabla u$$





Boundary Condition

$$\frac{\partial u}{\partial n} = 0\ in\ \partial\Omega\ \times\ (0, +\infty)$$