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REVIEWER'S REPORT

Manuscript No.: **IJAR-52501** Date: 27-06-2025

Title: **NUMERICAL RESOLUTION OF THE NON-LINEAR NON-ISOTROPIC DIFFUSION EQUATION IN DIMENSION 2 WITH NOISE EFFECT: APPLICATION TO IMAGE PROCESSING.**

Recommendation:

Accept as it is ....

Accept after minor revision.................

Accept after major revision ....

Do not accept (*Reasons below*) ....

Rating	Excel.	Good	Fair	Poor
Originality			✓	
Techn. Quality			✓	
Clarity			✓	
Significance			✓	

Reviewer Name: Mr Bilal Mir

Reviewer's Comment for Publication.

General Assessment:

This manuscript addresses a mathematically rigorous and practically significant problem: the application of numerical methods for solving nonlinear, non-isotropic diffusion equations in image processing, with particular emphasis on noise effects. The study stands at the intersection of applied mathematics, computational science, and digital image processing, offering insights into how advanced PDE models can enhance image quality and denoising performance. The inclusion of noise, particularly colored noise, into the diffusion framework is a strong and relevant addition, highlighting the complexity of real-world image acquisition systems.

Abstract Evaluation:

The abstract clearly states the core theme of the paper—numerical resolution of PDEs for image processing—and concisely summarizes the key finding that the proposed model, particularly when incorporating colored noise, outperforms classical models like Perona-Malik and Catte et al. It is succinct and informative, accurately reflecting the study's scope and contribution.

Introduction Evaluation:

The introduction is well-written and provides a clear rationale for the research. It begins by highlighting the widespread importance of image use in modern domains (meteorology, astronomy, medicine), then introduces the central problem—noise introduced by acquisition devices—and frames PDEs as a solution to various image processing tasks such as filtering, restoration, and segmentation. Historical context is

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appropriately provided, particularly the limitations of the classical heat equation, leading naturally into the motivation for non-linear approaches.

The mathematical presentation of the modified PDEs is precise. Equations (1.1) through (1.3) introduce the Perona-Malik model and its variants clearly, with proper emphasis on the choice and role of the diffusivity function g. The explanation of g's behavior (i.e., edge-preserving when g is decreasing) reflects a sound understanding of nonlinear diffusion filtering mechanics.

Methodological Strengths:
The mathematical formulation is coherent and reflects a solid theoretical foundation. The distinction between isotropic and non-isotropic diffusion is implicitly respected in the setup, and the addition of noise, particularly colored noise, suggests a high degree of realism in modeling. Although not all numerical and computational details are included in the excerpt, the structure suggests a methodical implementation of numerical schemes for time-dependent PDEs, likely involving finite differences or similar discretization techniques.

Results and Comparative Analysis (as described):
The claim that the proposed model surpasses the Perona-Malik and Catte et al. models under certain parameter settings is noteworthy. This implies not only qualitative improvements but also a quantitative evaluation based on objective statistical criteria, which adds credibility and practical relevance. While the explicit results are not shown in the provided text, the abstract implies that these were systematically analyzed and statistically validated.

Scientific and Practical Relevance:
This research is highly relevant for applied mathematics, computational imaging, and digital signal processing. By addressing the noise sensitivity of diffusion models and exploring modifications that maintain edge integrity while reducing noise, the study tackles a central challenge in image processing. Its utility spans a range of practical applications, from medical imaging to satellite data analysis.

Language and Presentation:
The manuscript is clearly written, with formal academic language that is accessible to readers familiar with numerical analysis and image processing. Mathematical expressions are well-integrated into the text, and the theoretical explanations are logically structured.

Overall Verdict:
The study represents a rigorous and meaningful contribution to the field of computational image processing through nonlinear PDE modeling. The novelty lies in the inclusion of colored noise in the diffusion model and the demonstration of its effectiveness over classical methods. The manuscript

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successfully bridges theoretical formulation and practical application, making it of interest to both mathematicians and engineers working on advanced image analysis techniques.