Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **31 (2024)** 321-337

SELF-SIMILAR SOLUTIONS FOR A NEW FREE-BOUNDARY PROBLEM AND IMAGE CONTOUR ENHANCEMENT

Hossemddine Achour[1] Rafaa Chouder[2] and Noureddine Benhamidouche[3]

[1]Laboratory of Pure and Applied Mathematics,
University of M'sila, University Pole, Road Bourdj Bou Arreiridj, M'sila 28000 Algeria

[2]Laboratory of Pure and Applied Mathematics,
University of M'sila, University Pole, Road Bourdj Bou Arreiridj, M'sila 28000 Algeria

[3]Laboratory of Pure and Applied Mathematics,
University of M'sila, University Pole, Road Bourdj Bou Arreiridj, M'sila 28000 Algeria

Abstract. The nonlinear diffusion equation is used to analyze the process of edge enhancement in image processing, based on a new evolution model consider as a generalization of mean curvature motion. A free boundary problem is formulated describing the image intensity evolution in the boundary layers around the edges of image. An asymptotic self-similar solutions to this nonlinear diffusion equation are obtained in explicit forms. The solutions demonstrated that the edge enhancement and its rates depends on the parameters of equation. The experimental results demonstrate the effectiveness of the model in edge preservation.

Keywords. Nonlinear diffusion equations - Mean curvature motion - Total variation flow - Image enhancement - Free boundaries - Self-similar solutions.

AMS (MOS) subject classification: 35C06 - 35Q94 - 35R35 - 65M22 - 65N22.

1 Introduction

Many mathematicians have been attracted by image processing and computer vision in recent years. Methods based on partial differential equations (PDEs) have been extensively used. Thus, it is not surprising that many partial differential equations (PDEs) and variational approaches have contributed substantially to the mathematical foundations of signal and image analysis. The nonlinear diffusion equation is known to have a significant application in solving image processing issues. The use of diffusion equations for image processing was first initiated with the work of Perona and Malik [11], where the authors proved that image intensity flux can lead to image edge enhancement if the flux is directed opposite to the image intensity gradient. This was followed by a series of papers, starting with the one by Alvarez et