Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **23 (2016)** 59-73

APPLICATIONS OF THE EULER - LAGRANGE POISSON ACTIVE CONTOUR IN VECTOR FIELDS, OVERCOMING NOISE, AND LINE INTEGRALS

Adam Bowden[1] and Dr. Nikolay Sirakov[1,2]

[1]Department of Mathematics, [2]Computer Science
Texas A&M University - Commerce, Commerce, Texas, USA

Abstract. This study is the continuation of work developing a new active contour (AC) model, where the Euler - Lagrange partial differential equation (PDE) is a minimizer of a functional whose minimum is on the boundaries of the image objects. The functional is constructed by internal forces coming from the AC and external forces generated from the image. In our model the external forces are the gradient of the solution of the Poisson PDE whose right side is the norm of the gradient of the image function. In the present paper, the negative of the norm and the divergence of the image function are used in the Poisson PDE to generate new vector fields to evolve the AC. The second contribution is the definition of coefficients which let the model evolve through heavy noise. The third novelty is the use of the AC's line integral to evaluate the abrupt boundary of skin lesions in dermoscopic images. The new achievements are validated on synthetic and dermoscopic skin lesion images.

Keywords. Minimization, Poisson PDE, Vector fields, Divergence, Line integrals.

AMS (MOS) subject classification: 68U10, 65M06, 65N06

1 Introduction

Critical to the applications of image analysis is the identification and extraction of object boundaries. With the advent of digital image processing, this area has been a focus of much research into the further development and implementation of image segmentation methods. Kass, Witkin, and Terzopoulos pioneered many early developments in image segmentation using a deformable active contour (AC) model [11]. This methodology has been further developed resulting in a wide variety of methods [4, 5, 7]. These have been used in a large range of applications, such as medical imaging, motion tracking, and facial recognition [2, 6, 9, 12, 16].

All AC methods seek to model an evolving and deforming contour, sometimes referred to as a "snake", which moves under certain constraints or forces prescribed by the model [8, 11]. These forces are defined in two different ways. The first are the so called "internal forces", which are a function of the contour causing the contour points to influence one another. The second are referred to as "external forces", which are a function of the image causing the contour to move toward boundaries.