Chapter 11
Momentum- and Resilient-Based Level Set for Medical Image Segmentation

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ABSTRACT

In this chapter, the authors present the technique of medical image segmentation which means to partition an image into non-overlapping regions based on intensity. The active contour is one of the most successful level set methods for segmentation and it is widely applicable in various image processing applications including medical image segmentation. Biomedical image segmentation and analysis plays an important role in medical science and healthcare. This chapter proposes a momentum term and resilient propagation-based gradient descent method which will remove the sensitivity of local minima of gradient descent. Proposed method is applicable in case of diseases like retinal, diabetic, and glaucoma, etc. Medical image segmentation via momentum and resilient propagation based gradient descent method can be optimized and effectively used. Extensive experiments have been performed over medical images to test the ability of the system. The proposed method is able to present the segmented medical image with clear and smooth boundary also it is simple to design and implementation.

INTRODUCTION

The active contour is one of the most successful level set methods for segmentation. Active contour based segmentation is based on energy functional and minimization of energy functional is known as segmentation (Kichenassamy, Kumar, Olver, Tannenbaum, & Yezzi, 1995; Cohen, 1991; Kass, Witkin, & Terzopoulos, 1988; Caselles, Kimmel, & Sapiro, 1995). The active contour model is a well-known image segmentation model which is widely applicable in various image processing applications such as in automated surveillance, graphics animation, robotics or medical image partition or segmentation.
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(Sundaramoorthi, Yezzi, & Mennucci, 2007; Charpiat, Keriven, Pons, & Faugeras, 2005). The contour motion equation is based on energy gradient depends upon Euler-Lagranges (Morse & Feshbach, 1993), it consists of evolving a contour in images toward the boundaries of objects or convergence. A parametric curve or contour are evolved according to minimization of cost functional up to convergence to an equilibrium state representing the segmentation. Medical image Segmentation is an important challenge in the field of image processing and computer vision. Steepest descent (gradient) is an important method for image segmentation. For, nonconvex functional various global optimization methods as Metropolis algorithm (Metropolis, Rosenbluth, Rosenbluth, Teller, & Teller, 1953), subdivision method (Kearfott, 1996), Monte-Carlo (Kirkpatrick, Gelatt, & Vecchi, 1983) techniques. Unfortunately these methods suffers from slow convergence. To improve the convergence method of evolving contours Mumford-Shah (Mumford & Shah 1989) Chen-Vese (Chan & Vese, 2001) and total variation (Chan, Esedoglu, & Nikolova, 2006; Bresson, Esedoglu, Vanderheynst, Thiran, & Osher, 2007) are used in order to fast convergence of boundary. Great efforts have been made to develop more advanced techniques in the field of segmentation in recent years. Image segmentation is the most essential and crucial process for facilitating the delineation, characterization, and visualization of regions of interest in any medical image. Automatic segmentation of medical images is a difficult task, since medical images are complex in nature and rarely have any simple linear feature. Enhancement of curvilinear object in medical images are obtained using matching filters, basic idea behind these filters is that locate the position of objects using some initial points. Therefore segmentation is based on selection of some initial points and spatial properties of objects. The backbone of any image segmentation is the heavily depends upon the feature extraction process using color or textures. Biomedical image retrieval using texture features superbly suited to the type of diseases present in the image (Quellec, Lamard, Cazuguel, Cochener & Roux, 2010; Traina, Castanon, & Traina, 2003, Zakeri, Behnam, & Ahmadinejad, 2012; Felipe, Traina, & Traina, 2003). A local diagonal pattern based on centre pixel and local diagonal neighbour are proposed (Dubey, Singh, and Singh, 2015) for CT images, a Directional binary wavelet patterns and local ternary co-occurrence matrix based texture are used for MRI and CT images (Murala, & Wu, 2013; Murala, Maheshwari, & Balasubramanian, 2012).

Segmentation is the process dividing an image into regions with similar properties such as gray level, color, texture, and shape. For medical image segmentation, mainly the aim is to:

- Study anatomical structure.
- Identify Region of Interest i.e. locate tumor, lesion, breakage of veins of retina and other abnormalities.
- Measure tissue volume to measure growth (for e.g. of tumor and also decrease in size of tumor with treatment).
- Help in treatment planning prior to radiation therapy.

Segmentation algorithms can be classified into two categories: low level and high level. The first category, which operates at the pixel level, includes five popular methods:

- Gray intensity or histogram analysis,
- Texture analysis,
- Edge enhancement and linking,
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