International Journal of Innovative
Computing, Information and Control
Volume **6**, Number **12**, December **2010**

 ISSN 1349-4198
pp. 5565–5574

A SEGMENTATION ALGORITHM FOR BRAIN MR IMAGES USING FUZZY MODEL AND LEVEL SETS

Zhibin Chen[1,2,3], Tianshuang Qiu[1] and Su Ruan[3]

[1]Department of Electronic Engineering
Dalian University of Technology
Dalian 116024, P. R. China
zbchen69@163.com; qiutsh@dlut.edu.cn

[2]School of Electronic and Information Engineering
University of Science and Technology Liaoning
Anshan 114044, P. R. China

[3]CReSTIC, IUT de Troyes
Université de Reims Champagne Ardenne
Troyes Cedex 10026, France
su.ruan@univ-reims.fr

Received August 2009; revised February 2010

Abstract. *This paper presents a novel algorithm based on level set techniques for tissue segmentation of brain magnetic resonance (MR) images. The method initially proposed by Suri is improved by using a new regional term based on the investigation and analysis of its stability. The improved algorithm solves the stability problem associated with the original algorithm resulting in a greatly improved quality in MR image segmentation. The multi-seed initialization is used to minimize the sensitivity of the proposed algorithm to the initial condition, as well as speeds up overall convergence. Both simulated and real MR images experiments demonstrate the feasibility and the effectiveness of the improved algorithm, as evidenced by the successful segmentation for various cerebral tissues (white matter, gray matter, and cerebrospinal fluid) of a variety of modal images (T1-, T2- and PD-weighted MR images). Quantitative evaluations of the segmentation results indicate the good performance of the proposed method.*

Keywords: Tissue segmentation, Fuzzy clustering, Level sets, Magnetic resonance images

1. **Introduction.** The role of magnetic resonance imaging (MRI) has become increasingly important in clinical use due to its high spatial resolution and good discrimination of soft tissues. Advanced application using morphological contents of MRI frequently requires the segmentation of brain matter into different tissue types, such as gray matter (GM), white matter (WM) and cerebrospinal fluid (CSF). These applications include multimodality image correction, visualization, tumor and lesion detection [1], brain development and human aging [2], diagnosis, treatment and the general understanding of certain diseases like Alzheimer and hydrocephalus [3]. Many approaches for segmentation of brain MR images have already been proposed in the past.

Extant bodies of literature favor the use of fuzzy segmentation over hard segmentation. In the study of Shen et al. [4], neighborhood attraction is used to extend the traditional fuzzy c-means (FCM) algorithm to the segmentation of brain tissues. Liew and Yan, taking into account spatial continuity constraints, reduced the noise effect and refined classification ambiguities [5]. Pham and Prince employed the FCM method to classify MR image tissues by iteratively adapting to the intensity homogeneities [6]. Wang et