8th AUN/SEED-Net

REGIONAL CONFERENCE ON ELECTRICAL AND ELECTRONICS ENGINEERING

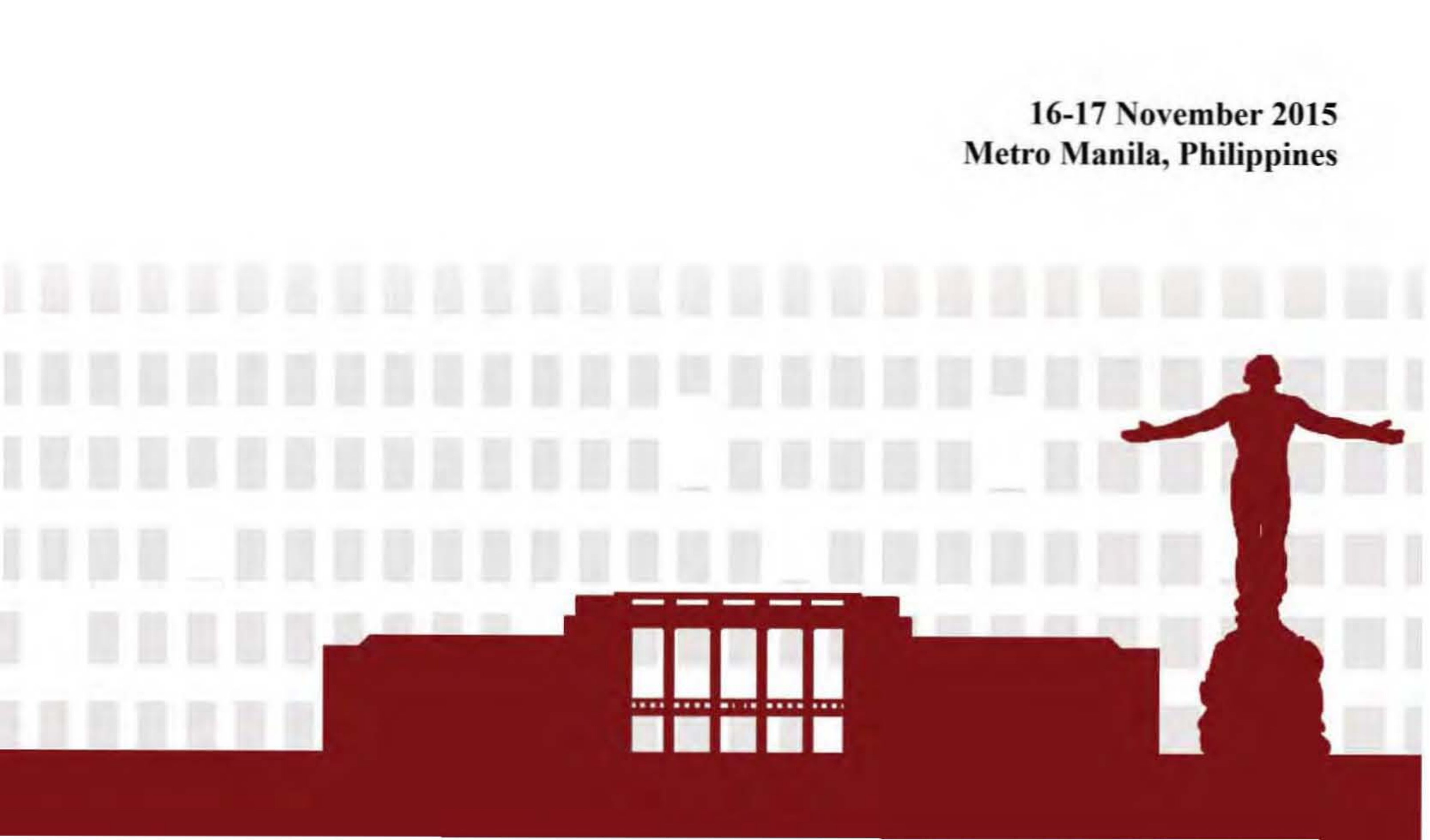
Envision, Enable, and Empower
Smarter and Resilient Societies

co-located with

11th ERDT Conference

on Semiconductor and Electronics, Information and Communications Technology and Energy

16-17 November 2015
Metro Manila, Philippines



Proceedings of the 8th AUN/SEED-Net RCEEE 2015 and 11th ERDT Conference on Semiconductor and Electronics, Information and Communications Technology, and Energy

Editors:
Dr. Joel Joseph S. Marciano Jr.
Dr. Jhoanna Rhodette I. Pedrasa
Dr. Rhandley D. Cajote

ISBN: 978-616-406-075-3

Published by: ASEAN University Network / Southeast Asia Engineering Education Development Network (AUN/SEED-Net) JICA Project
Faculty of Engineering, Bldg. 2
Chulalongkorn University, Bangkok
Thailand 10330

Printed in the Philippines by: ERZALAN PRINTING PRESS
45 Cotabato Street, Luzviminda Village, Batasan Hills, Quezon City, Philippines

8th AUN/SEED-Net Regional Conference
on Electrical and Electronics Engineering 2015

co-located with

11th ERDT Conference
on Semiconductor and Electronics, Information and Communications Technology, and Energy

Envision, Enable and Empower Smarter and Resilient Societies

Published by: ASEAN University Network / Southeast Asia Engineering Education Development Network (AUN/SEED-Net) in partnership with Engineering Research and Development for Technology (ERDT) and University of the Philippines Diliman.

ISBN: 978-616-406-075-3

ASSESSMENT OF ROBUST MRI BRAIN SEGMENTATION METHODS TOWARD DIAGNOSING OF ALZHEIMER'S DISEASE

Jantana Panyavaraporn[1] *, Songphon Chamniansong[1] and Paramate Horkaew[2]

[1] Department of Electrical Engineering, Faculty of Engineering, Burapha University, THAILAND.
[2] School of Computer Engineering, Suranaree University of Technology, Nakornrachasima, THAILAND.
• E-mail: Jantanap@eng.buu.ac.th

ABSTRACT
Whole brain segmentation from MR image is a key process toward higher level processing required by computerized Alzheimer's diagnosis. Delineated structures serve as the domain for subsequent hippocampus and other tissue segmentation. This paper proposed a robust method which involves less intervention from the user, compared to the conventional 2D geometric figure, based on a Level Set. Both methods were benchmarked on the T1 MR images obtained from the Alzheimer's disease Neuroimaging Initiative (ADNI) database. The experimental results reported herein indicated that the proposed method can extract the whole brain structure more accurately than its counterpart.

Keywords: MRI; ADNI; Level Set; Segmentation

1. Introduction
Alzheimer's disease (AD) is a degenerative disease which causes the brain to gradually shrink and later incapacitated. AD affects almost 50% of those over the age of 85 and as such is a top ten leading cause of death. Current diagnosis of Alzheimer's disease is carried out by clinical, neuropsychological, and/ or neuroimaging assessments. Magnetic Resonance (MR) has been considered a preferred neuroimaging modality for examining the AD as it enables accurate assessment of relevant organs such as hippocampus and related peripherals [1].

More recently, some previous researches have been successfully determining the prognostic outcomes of AD from MR images. Their methods involve interpreting spatial information derived from pixels intensities [2-3]. [2], for example, proposed an ad-hoc scheme for segmenting the whole brain structure based on mathematical morphology. In their work, assumptions on the geometric figures and their gross dimensions needed to be specified based on anatomical a priori. These assumptions are highly view dependent and maybe unable to remove spurious objects completely. Another pixel based method was proposed in [3], which segmented the brain structure by an adaptive thresholding. Alternatively, without extracting any object, [4] transformed the entire axial images using 2D Gabor Wavelet whose coefficient were used to classify the disease.

Similar to [1], this paper focus on extracting anatomical domain, i.e., the whole brain based on a Level Set method [5]. Unlike the "2D geometric method", the Level Set (LS) method did not require exact anatomical geometry of the brain except that on its connectivity. Moreover, it is more robust against noise and tonal variations, compared to a generic pixel based threholding [3] and against subjects and scans variability, compared to global brain classification [4].

This paper is organized as follows. The segmentation methods are presented in Section 2. Section 3 reports the analytical results of segmented whole brain structure. Conclusions and future works are given in Section 4.

2. Segmentation Methods

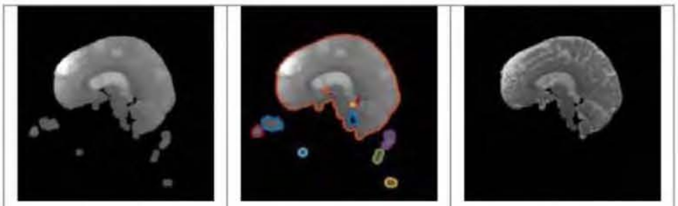
2.1 2D Geometric Method
Following [1], a set of geometric object were estimated from a sagital brain scan using gross anatomical data [1]. Once the rough brain outlines (Fig. 1(a)) were extracted the double thresholding followed by morphological opening were applied (Fig 1(b)). The binary mask was then overlaid on the original image from which a disk filter was applied to further remove noise and spurious structures (Fig. 1(c)).

(a)	(b)	(c)

Figure 1. An example of a brain segmentation by using 2D Geometric Method

2.2 Level Set Method

The Level Set (LS) method is a numerical analysis of shapes as a projection of the embedding surface in higher dimension, introduced by Osner and Sethian [5]. This paper followed the implementation by [7]. As a preparation, Otsu thresholding [6] followed by morphological opening was applied on the brain image. Based on these segmented regions, a respective 3D surface was reconstructed and propagated by using LS method [7], to extract the region of interest from its level set, as shown in Figure 2 (a-c).



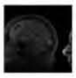
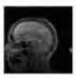
(a)	(b)	(c)

Figure 2. Example of a brain segmentation using Level Set method

3. Experimental Results

This paper assessed both these methods on 256   256 pixels T1 MRI from the ADNI (http://adni.loni.usc.edu/) database. The experiment was divided into 2 parts. The first part involved segmenting the brain images following [1] while the latter did so using the LS method. The compared results are presented in Table 1.

Table I. Comparing 2D Geometric Against Lsm

ID	Original Image	2D Geometric	LSM
007_S_1206			
012_S_2118			
013_S_4268			
013_S_4395			
002_S_0295			
002_S_0729			
002_S_0816			
002_S_0938			

It is clear from the second column that the 2D geometric figure failed in segmenting a whole brain image, incorrectly dividing it into separated regions. This was probably due to the improper use of double threholding on MRI with ramp offset (gradual tonal variation). Likewise, in few cases, the hippocampus was wrongly discarded. On the other hand, irrelevant objects (spurious structures) remained present as it was enclosed by the presumed geometry. This highlights the pitfall of ad-hoc anatomical geometry which does not necessarily reflect the *in vivo* samples.

Conclusions and Future Works

This paper proposed a Level Set based robust brain segmentation. The segmented region was represented by its level set of evolving surface. The experimental results showed that both methods could segment brain. Upon closer visual inspection, however, compared with conventional 2D geometric figure, our proposed method was able to provide more realistic brain segmentation, whose region was singly connected, without artifacts void or any irrelevant objects. Unlike its counterpart, our method could preserve the hippocampus structures which are crucial for the subsequent AD analysis. Once the whole brain image was accurately extracted from MRI, our future research interests include classifying the segmented brains and enclosed structures. The model is expected to serve as a preliminary indicator for determining symptomatic from asymptomatic AD in an actual scans.

Acknowledgment

This work was financially supported by the Research Grant of Burapha University through National Research Council of Thailand (Grant no. 116/2557 and 128/2558). Database sharing for this project was supported by Alzheimer's Disease Neuroimaging Initiative (AND).

References

[1] T. S. Ramachandran, "Alzheimer Disease Imaging," acquired from "http://emedicine.medscape.com/article/336281-overview", Jul 27, 2014.

[2] C. Tanchi, N. Theera-Umpon, and S. Auephanwiriyakul, "Fully Automatic Brain Segmentation for Alzheimer's Disease Detection from Magnetic Resonance Images," Joint 6th International Conference on Soft Computing and Intelligent System and 13th International Symposium on Advanced Intelligent System, pp. 1393-1396, Nov 2012.

[3] K. Somasundaram and T. Kalaiselvi, "Automatic Brain Extraction Methods for T1 Magnetic Resonance Images using Region Labeling and Morphological Operations," Journal of Computers in Biology and Medicine, pp. 716-725, 2011.

[4] P. Padilla, et al., "Alzheimer's Disease Detection in Functional Images using 2D Gabor Wavelet Analysis," Journal of Electronic Letter, vol. 46, no. 8, April 2010.

[5] S. Osher and J. A. Sethian,"Fronts propagating with curvature-dependent speed: Algorithms based on Hamilton–Jacobi formulations," Journal of Computational Physics, vol. 79, pp.12–49, 1988.

[6] Z. Hu, st all, "Teeth Segmentation Using Dental CT Data," 7th International Conference on BioMedical Engineering and Informatic, pp. 81-84, October 2014.

[7] R. Malladi, J. A. Sethian and B. C. Vemuri, "Shape Modeling with Front Propagation: A Level Set Approach," IEEE Trans. on Panttern Analysis and Machine Intelligence, vol. 17, no. 2, February 1995.