International Journal of Innovative Computing, Information and Control
Volume **7**, Number **8**, August **2011**

ICIC International ©2011 ISSN 1349-4198
pp. **4965–4976**

UNSUPERVISED FUZZY C-MEANS CLUSTERING FOR MOTOR IMAGERY EEG RECOGNITION

Wei-Yen Hsu[1,4], Chi-Yuan Lin[2], Wen-Feng Kuo[3], Michelle Liou[1]
Yung-Nien Sun[4], Arthur Chih-Hsin Tsai[1], Hsien-Jen Hsu[5]
Po-Hsun Chen[6] and I-Ru Chen[7]

[1]Institute of Statistical Science
Academia Sinica
No. 128, Academia Road, Sec. 2, Nankang, Taipei 115, Taiwan
shenswy@stat.sinica.edu.tw; shen@csie.ncku.edu.tw

[2]Department of Computer Science and Information Engineering
National Chin-Yi University of Technology
No. 35, Lane 215, Sec. 1, Chung-Shan Road, Taiping City, Taichung 411, Taiwan

[3]Department of Medical Informatics
National Cheng Kung University Hospital
No. 138, Sheng Li Road, Tainan 701, Taiwan

[4]Department of Computer Science and Information Engineering
[5]Institute of Manufacturing Information and Systems
[6]Department of Electrical Engineering
National Cheng Kung University
No. 1, Ta-Hsueh Road, Tainan 701, Taiwan

[7]Department of Mathematics
Fu Jen Catholic High School
No. 270, Wu-Fon-Nan Road, Chia-I, Taiwan

Received April 2010; revised August 2010

Abstract. *In this study, an electroencephalogram (EEG) recognition system is proposed on single-trial motor imagery (MI) data. Fuzzy c-means (FCM) clustering is used for the unsupervised recognition of left and right MI data by combining with selected active segments and multiresolution fractal features. Active segment selection is used to detect active segments situated at most discriminable areas in the time-frequency domain. The multiresolution fractal features are then extracted by using modified fractal dimension from wavelet data. Finally, FCM clustering is used as the discriminant of MI features. The FCM clustering is an adaptive approach suitable for the clustering of non-stationary biomedical signals. Compared with several popular supervised classifiers, FCM clustering provides a potential for BCI application.*
Keywords: Brain-computer interface (BCI), Electroencephalogram (EEG), Motor imagery (MI), Fractal dimension (FD), Fuzzy c-means (FCM)

1. **Introduction.** The brain-computer interface (BCI) providing analternative channel to directly transmit messages to computers from the human brain by analyzing the brain's mental activities [1-6] is a new communication system. BCI systems based on the single-trial analysis of motor imagery (MI) electroencephalographic (EEG) signals have grown rapidly in the last decade [2]. It focuses on the recognition of left and right MIs using event-related brain potentials (ERP), which reveal that they possess special characteristics of event-related desynchronization (ERD) and synchronization (ERS) in mu and beta rhythms over the sensorimotor cortices during MI tasks [7-9].