



Low-Power Architecture for Epileptic Seizure Detection Based on Reduced Complexity DWT

MRIGANK SHARAD, SUMEET K. GUPTA, SHRIRAM RAGHUNATHAN, PEDRO P. IRAZOQUI, and KAUSHIK ROY, Purdue University

In this article, we present a low-power, user-programmable architecture for discrete wavelet transform (DWT) based epileptic seizure detection algorithm. A simplified, low-pass filter (LPF)-only-DWT technique is employed in which energy contents of different frequency bands are obtained by subtracting quasi-averaged, consecutive LPF outputs. Training phase is used to identify the range of critical DWT coefficients that are in turn used to set patient-specific system level parameters for minimizing power consumption. The proposed optimizations allow the design to work at significantly lower power in the normal operation mode. The system has been tested on neural data obtained from kainate-treated rats. The design was implemented in TSMC-65nm technology and consumes less than 550-nW power at 250-mV supply.

Categories and Subject Descriptors: B.7.1 **[Integrated Circuits]**: Types and Design Styles

General Terms: Algorithms, Design

Additional Key Words and Phrases: Epilepsy, seizure detection, low power, biomedical

ACM Reference Format:

Sharad, M., Gupta, S. K., Raghunathan, S., Irazoqui, P. P., and Roy, K. 2012. Low-power architecture for epileptic seizure detection based on reduced complexity DWT. *ACM J. Emerg. Technol. Comput. Syst.* 8, 2, Article 10 (June 2012), 14 pages.

DOI = 10.1145/2180878.2180882 <http://doi.acm.org/10.1145/2180878.2180882>

1. INTRODUCTION

Epilepsy is a dynamically nonstationary transient symptom of excessive and/or synchronous neuronal activity in certain sections or the entire brain. It is one of the most common chronic neurological disorders affecting more than 50 million people across the globe. Most of the medical treatments for epilepsy that focus on controlling the occurrence of seizures prove ineffective for about 30% of the seizure patients [Raghunathan et al. 2009]. Alternative treatments based on electrical stimulation have been shown to be promising [Binder and Scharfman 2004]. However, continuous stimulation reduces the responsiveness of the tissue to electrical stimulation and may pose a threat to the patient's normal neurological operations [Raghunathan et al. 2009]. Responsive neuro-stimulation is an alternate therapy that requires efficient real-time seizure detection techniques that precisely identify the onset of seizure and trigger the stimulation.

In order to come up with an implantable design for seizure detection and stimulation control, it is of paramount importance to identify low-cost signal processing

This work was supported in part by the Cyberonics and the National Science Foundation.

Authors' address: M. Sharad, S. K. Gupta, S. Raghunathan, P. P. Irazoqui, and K. Roy, Purdue University, West Lafayette, IN 47907; email: msharad@purdue.edu.

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies show this notice on the first page or initial screen of a display along with the full citation. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers, to redistribute to lists, or to use any component of this work in other works requires prior specific permission and/or a fee. Permissions may be requested from the Publications Dept., ACM, Inc., 2 Penn Plaza, Suite 701, New York, NY 10121-0701, USA, fax +1 (212) 869-0481, or permissions@acm.org.

© 2012 ACM 1550-4832/2012/06-ART10 \$10.00

DOI 10.1145/2180878.2180882 <http://doi.acm.org/10.1145/2180878.2180882>