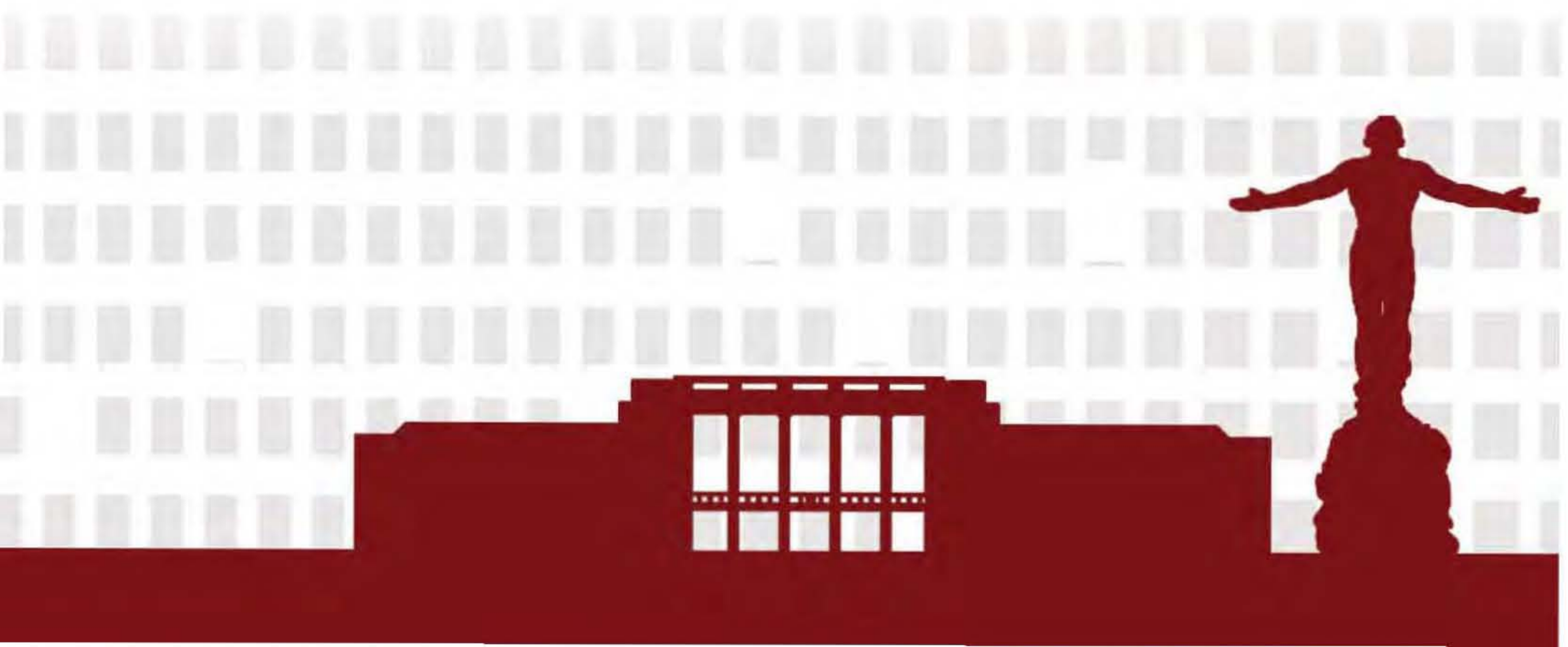
AUN/SEED-Net

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

MICROCONTROLLER-IMPLEMENTED ARTIFICIAL NEURAL NETWORK FOR ELECTROOCULOGRAPHY-BASED WEARABLE DROWSINESS DETECTION WITH ALERT SYSTEM

Keith Marlon R. Tabal*, Felicito S. Caluyo and Joseph Bryan G. Ibarra

Mapua Institute of Technology, PHILIPPINES.
*E-mail: k.r.tabal@ieee.org

ABSTRACT

Drowsiness has been one of the leading causes of work-related accidents. One reason that is pointed out by the Royal Society for the Prevention of Accidents (2001) is that, drowsiness tends to reduce the reaction time and attentiveness of a person resulting to poor performance on attention-based activities. This is due to the fact that the speed at which information is processed in the brain is also reduced by drowsiness (NCSDR/NHTSA 1998).

Different methods have been explored to develop an effective drowsiness detection system (DDS) to give drivers warning of impending drowsiness. However, no study implemented a wearable and standalone DDS. Most of the existing DDS require the use of a computer application or a separate processor for signal processing and drowsiness detection. The present study aimed to design a wearable electrooculography (EOG)-based DDS that doesn't require a computer to operate; to implement an artificial neural network (ANN) into a microcontroller; to determine the best electrode placement setup on the visor cap for optimal extraction of EOG signals; to test the accuracy, precision and sensitivity of the system in real-time; and to evaluate the system in terms of comfort and unobtrusiveness. Figure 1 below shows the methodology from which the the development of the system was based upon.

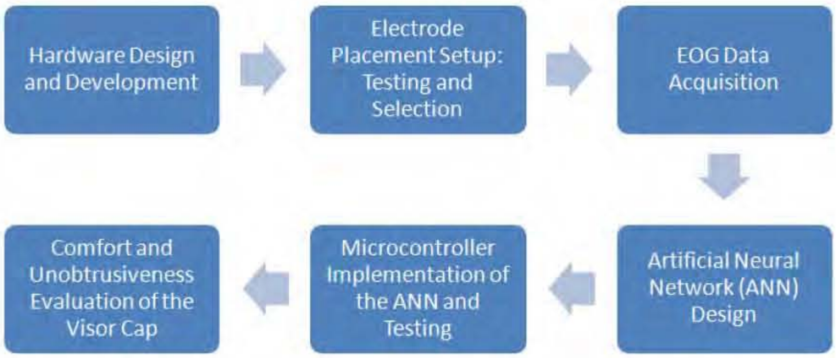


Figure 1. Methodology

The function of the EOG-based drowsiness detection with alert system focused primarily on detecting whether a person is drowsy or not. The testing was done by emulating the blinking behavior on a normal and drowsy state. A feed-forward neural network was used in the system and was trained using the back-propagation algorithm through a supervised learning. Blink duration patterns were used as basis for drowsiness detection. The construction of the system was based on the conceptual block diagram as shown in Figure 2. An Arduino LilypadUSB microcontroller was used as the main controller of the system, an analog band-pass filter/amplifier, a vibrator and a beeper for the alarm, and Silver/Silver-Chloride (Ag/AgCl) electrodes for the extraction of the vertical EOG signals. The entire system is battery operated which allows it to be embedded into the interior of the custom-built visor cap.

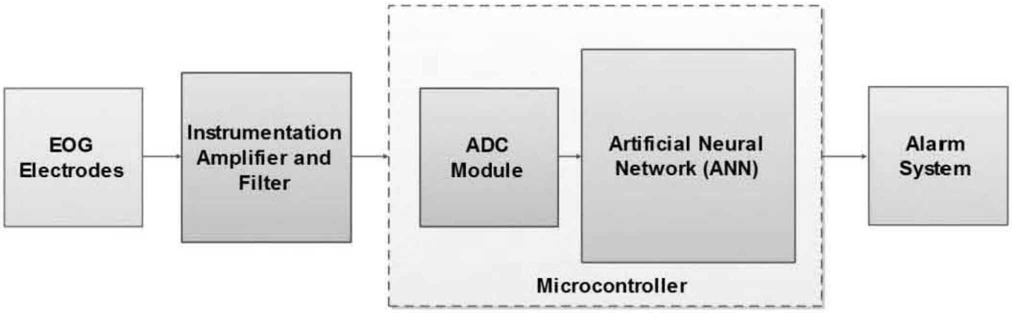


Figure 2. EOG-based Drowsiness Detection System Block Diagram

Among the fifty (50) blinks performed by the test subject, the system was able to positively identify forty-six (46) normal blinks while for the drowsy blinks, the system was able to positively identify forty-four (44). Using the Confusion Matrix (Kohavi, R. and F. Provost 1998), the performance of the system for drowsiness classification was evaluated with an overall accuracy of 90.00%, precision of 88.00%, sensitivity of 91.67%. For the evaluation for comfort and unobtrusiveness, the rating of the subjects had a mean of 3.60 and 4.10, respectively which both fall under the very good criterion.

Keywords: Artificial neural network, electrooculography, drowsiness detection, microcontroller implementation.

Acknowledgment
The author[1] would like to thank the Engineering Research and Development for Technology, Department of Science and Technology – Science Education Institute (ERDT, DOST-SEI) for the scholarship and for funding this study.

References
[1] Driver Fatigue and Road Accidents: A Literature Review and Position Paper. The Royal Society for the Prevention of Accidents (RoSPA), February (2001)

[2] Drowsy Driving and Automobile Crashes.: NCSDR/NHTSA Expert Panel on Driver Fatigue and Sleepiness, Report HS 808 707, (1998)

[3] Kohavi, R. and F. Provost.: On Applied Research in Machine Learning. In Editorial for the Special Issue on Applications of Machine Learning and the Knowledge Discovery Process. Columbia University, New York, vol. 30, (1998)