MECHATRONICS BOOK SERIES: SYSTEM DESIGN AND SIGNAL PROCESSING - VOLUME 1

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CONTENTS

Editorial Notes........................................................................................................... v
About the Editors........................................................................................................ vi
Contents..................................................................................................................... vii

1 Energy Harvesting For Wide Area Sensor Networks.............................................. 1
   Nahrul Khair Alang Md Rashid and Mohamad Ghazali Ameer Amsa

2 Design And Development Of Automatic Paper Box Folding Machine............... 8
   Md Mozasser Rahman, Anwar Hussain bin Mohamed Rasied and Ahmad Zulkamal Ismail

3 Intelligent Shoe Guard System.............................................................................. 20
   M. J. E. Salami, A. M. Aibinu, Siti Sarah binti Mohd Sufian

4 Applications of Mechatronics Engineering In Modern Agriculture............... 29
   Nahrul Khair Alang Md Rashid

5 Mathematical Modeling of Counter Flow Scrubber Using Eulerian-Lagrangian Approach................................................................. 34
   Bashir Ahmed Danzomo and Momoh Jimoh E. Salami

6 Auto Landmarks Generation For SLAM Algorithm............................................ 42
   Nahrul Khair Alang Md Rashid and Imama Karim Manba Usama

7 Automatic Intelligent Ordering System Design and Tools Selection............... 46
   Siti Fauziah Toha and Rosdiazi Ibrahim

8 Design And Development of a Sorting Machine Using Multiple Sensory System ................................................................. 52
   Md Mozasser Rahman, Siti Fatimah binti Abdul Rahim
Design and Development of Intelligent Wiper for Vehicle Windshield: Mechanical Design

Shahrul Na'im Sidek, Abd Rahman Ibrahim

Design and Development of Intelligent Wiper for Vehicle Windshield: Electrical Design

Shahrul Na'im Sidek, Mohammad Asfamuddin Ab Aziz

Design and Development of Intelligent Wiper for Vehicle Windshield: Final Assembly And Results

Shahrul Na'im Sidek, Mohammad Asfamuddin Ab Aziz

Design and Prototyping of Inertia Wheel


Design and Implementation of Instant Noodles Vending Machine

M.M. Rashid

Mathematical Model for Three Tank System

W. Astuti, R. Alimuddin, A.M. Aibinu, Momoh Jimoh E.Salami and Wahyudi Martono

Design of Software Tool to Detect QRS Complex from ECG Signal

Wahju Sediono

Development of a Jet Powered Floating Platform (In Air)

M. Zharif, Raisuddin Khan and Masum Billah

Development of Experimental Station for Earthquake Prediction

A. M. Aibinu, M. J. E. Salami, Asan Gani Muthalif, Sumaiyah Mior Badri, Sarah Kahlidah and Nuruleeman Saat

Development of Robotic Manipulator to Assist Human by Using Brain Signal

Rodhiah, Raisuddin Khan and Masum Billah

Development of Unmanned Aerial Vehicle – Part I

Shahrul Na'im Sidek, M. Ismail Mohtar, A Mushawwir M Khalil
<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Development of Unmanned Aerial Vehicle – Part 2</td>
<td>Shahrul Na'im Sidek, A Mushawwir M Khalil, M. Ismail Mohtar</td>
</tr>
<tr>
<td>23</td>
<td>Electrooculography (EOG)-Controlled Wheelchair</td>
<td>Shahrul Na'im Sidek, M. Iqbal Zakaria and A. Ridwan A. Aziz</td>
</tr>
<tr>
<td>24</td>
<td>Conceptual Design of an Intelligent Coconut Dehusking</td>
<td>M. J. E. Salami, A. M. Abibu</td>
</tr>
<tr>
<td>25</td>
<td>An Electrooculogram (EOG) Signal for Wheelchair Motion Control</td>
<td>Salmiah Ahmad, Nurul Muthmainnah Mohd Noor</td>
</tr>
<tr>
<td>27</td>
<td>GIS-Based Vehicle Traffic Simulation</td>
<td>Wahju Sediono</td>
</tr>
<tr>
<td>28</td>
<td>Intelligent Postal Mails Sorter</td>
<td>Mohd Arif Faiz Bin Omar, Mohd Zain Bin Ismail, M. J. E. Salami, A. M. Abibu</td>
</tr>
<tr>
<td>29</td>
<td>Intelligent Wet Scrubber System for Industrial Air Pollution Control</td>
<td>Bashir Ahmed Danzomo and Momoh Jimoh E. Salami</td>
</tr>
<tr>
<td>30</td>
<td>Leveraging on Nature for Systems Design</td>
<td>Nahrul Khair Alang Md Rashid and Safinaz Kader Mohideen</td>
</tr>
<tr>
<td>31</td>
<td>Natural Ventilation of Yam Storage System</td>
<td>Murtala Abdulazeez, M.J.E. Salami, Md. Raisuddin Khan</td>
</tr>
<tr>
<td>32</td>
<td>Self-Repair Capability in Engineering Systems</td>
<td>Nahrul Khair Alang Md Rashid and Aous Naji Rasheed</td>
</tr>
<tr>
<td>Page</td>
<td>Title</td>
<td>Author(s)</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>33</td>
<td>Simulation of Airflow and Temperature Distribution in Yam Storage System</td>
<td>Murtala Abdulazeez, M.J.E. Salami, Md. Raisuddin Khan,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nabeel Adeyemi</td>
</tr>
<tr>
<td>34</td>
<td>Sound Identification in Noisy Environment</td>
<td>Nahrul Khair Alang Md Rashid, Nor Hidayati Diana Nordin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and Alim Sabur Ajibola</td>
</tr>
<tr>
<td>35</td>
<td>Intelligent CCTV-Based Monitoring System for Kulliyyah of Engineering, IIUM</td>
<td>M. J. E. Saslami, A. M. Aibinu and Nur Syahrain binti</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mohd Jahini</td>
</tr>
<tr>
<td>36</td>
<td>Virtual Modeling of Two-Wheeled Wheelchair using Msc Visual Nastran 4D</td>
<td>Salmiah Ahmad, M. O. Tokhi</td>
</tr>
</tbody>
</table>
CHAPTER 23

Electrooculography-Controlled Wheelchair

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23.1 Introduction

The electrooculography (EOG) is a technique for measuring and recording eye movements via a voltage difference between the cornea and retina. As the eye moves, the vector of this electric field changes with respect to a reference electrode. At least two biopotential channels are required when recording eye movements to assist in distinguishing eye movement potentials from other signal artifacts. The amplitude of the EOG signal is very small and varies from 0.05 mV to 3.5 mV with a frequency range of about 0 to 50Hz.

There are many disabled who depend on wheelchair to move around. Recently there has been a significant increase in the development of assistive technology for people with disabilities. The eye movement seems to have a big potential to be incorporated into the operation of wheelchair so as to assist the disabled to be more independent to manage their life.

23.2 System Background

There are quite a number of applications that utilize EOG signals as a mean to drive the system. [1] reported the use of EOG in tracking problem for Human Computer Interface (HCI). The objective of this system is to position the cursor on the screen from the information recorded from the user's EOG signals. The interface system works exactly like the mouse-movement to control a cursor in a computer. Through the work of [2], they presented a guided scheme to control a wheelchair. The command schemes are affected by means of the following ocular actions: UP: The wheelchair moves forward, DOWN: The wheelchair moves backward, RIGHT: The wheelchair moves to the right, LEFT: The wheelchair moves to the left.

[3] developed vehicle driver drowsiness detection system using EOG. The system tracks the eye motion during drowsiness. However, the system requires high computing power due to real time video processing. It is reported by [4] that by using the dynamic natural eye orientation signal, one could control the orientation of artificial eye more naturally. A small servomotor is used to drive the artificial eye.

23.3 System Description

In general, the first part of the system is to extract the EOG signal by means of electrodes and signal conditioning circuit. The analog signal is then digitized before being transmitted to the wheel chair control system. Here, the signal will be manipulated to generate the control command to the motor in order to move the wheelchair accordingly.

In particular, to obtain the HEOG signal using one channel signal acquisition system, a pair of electrodes is used to capture the signal as input to the instrumentation amplifier (INA 126). The difference between these two inputs is amplified by the instrumentation amplifier. The gain of the instrumentation amplifier can be adjusted from 5 to 10000. The requirement to amplify the EOG signal is because the actual amplitude of the signal is very small (0.05-3.5mV). According to