

# **MECHATRONICS BOOK SERIES SYSTEM DESIGN AND SIGNAL PROCESSING VOLUME 1**

---

## **Editors**

**Asan G. A. Muthalif  
Amir Akramin Shafie  
Siti Fauziah Toha  
Iskandar Al-Thani Mahmood**



**IIUM PRESS**

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

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

---

**Editors**

Asan G. A. Muthalif  
Amir Akramin Shafie  
Siti Fauziah Toha  
Iskandar Al-Thani Mahmood



IIUM Press

Published by:  
IIUM Press  
International Islamic University Malaysia

First Edition, 2011  
©IIUM Press, IIUM

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without any prior written permission of the publisher.

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

ISBN: 978-967-418-173-4

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM  
(Malaysian Scholarly Publishing Council)

Printed by :  
**IIUM PRINTING SDN.BHD.**  
No. 1, Jalan Industri Batu Caves 1/3  
Taman Perindustrian Batu Caves  
Batu Caves Centre Point  
68100 Batu Caves  
Selangor Darul Ehsan  
Tel: +603-6188 1542 / 44 / 45 Fax: +603-6188 1543  
EMAIL: iiumprinting@yahoo.com

# CONTENTS

<b>Editorial Notes</b> .....	v
<b>About the Editors</b> .....	vi
<b>Contents</b> .....	vii
1 Energy Harvesting For Wide Area Sensor Networks.....	1
<i>Nahrul Khair Alang Md Rashid and Mohamad Ghazali Ameer Amsa</i>	
2 Design And Development Of Automatic Paper Box Folding Machine.....	8
<i>Md Mozasser Rahman, Anwar Hussain bin Mohamed Rasied and Ahmad Zulkamal Ismail</i>	
3 Intelligent Shoe Guard System.....	20
<i>M. J. E. Salami,, A. M. Aibinu, Siti Sarah binti Mohd Sufian</i>	
4 Applications of Mechatronics Engineering In Modern Agriculture.....	29
<i>Nahrul Khair Alang Md Rashid</i>	
5 Mathematical Modeling of Counter Flow Scrubber Using Eulerian-Lagrangian Approach.....	34
<i>Bashir Ahmed Danzomo and Momoh Jimoh E. Salami</i>	
6 Auto Landmarks Generation For SLAM Algorithm.....	42
<i>Nahrul Khair Alang Md Rashid and Imama Karim Manba Usama</i>	
7 Automatic Intelligent Ordering System Design and Tools Selection.....	46
<i>Siti Fauziah Toha and Rosdiazli Ibrahim</i>	
8 Design And Development of a Sorting Machine Using Multiple Sensory System.....	52
<i>Md Mozasser Rahman1, Siti Fatimah binti Abdul Rahim</i>	

9	Design And Development Of Intelligent Wiper For Vehicle Windshield: <b>Mechanical Design</b> .....	58
	<i>Shahrul Na'im Sidek, Abd Rahman Ibrahim</i>	
10	Design and Development of Intelligent Wiper for Vehicle Windshield: <b>Electrical Design</b> .....	63
	<i>Shahrul Na'im Sidek, Mohammad Afhamuddin Ab Aziz</i>	
11	Design and Development of Intelligent Wiper for Vehicle Windshield: Final Assembly And Results.....	68
	<i>Shahrul Na'im Sidek, Mohammad Afhamuddin Ab Aziz</i>	
12	Design and Prototyping of Inertia Wheel.....	73
	<i>W. Astuti, A. R. Kasim, M. I. Solihin, A.M. Aibinu, Momoh Jimoh E.Salami and Wahyudi</i>	
13	Design and Implementation of Instant Noodles Vending Machine.....	80
	<i>M.M.Rashid</i>	
14	Mathematical Model for Three Tank System.....	88
	<i>W. Astuti, R. Alimuddin, A.M. Aibinu, Momoh Jimoh E.Salami and Wahyudi Martono</i>	
15	Design of Software Tool to Detect QRS Complex from ECG Signal.....	98
	<i>Wahju Sediono</i>	
16	Development of a Jet Powered Floating Platform (In Air).....	104
	<i>M. Zharif, Raisuddin Khan and Masum Billah</i>	
17	Development of Experimental Station for Earthquake Prediction.....	109
	<i>A. M. Aibinu, M. J. E. Salami, Asan Gani Muthalif, Sumaiyah Mior Badri, Sarah Khalidah and Nuruleeman Saat</i>	
18	Development of Robotic Manipulator to Assist Human by Using Brain Signal.....	117
	<i>Rodhiah, Raisuddin Khan and Masum Billah</i>	
19	Development of Unmanned Aerial Vehicle – Part 1.....	123
	<i>Shahrul Na'im Sidek, M. Ismail Mohtar, A Mushawwir M Khalil</i>	

20	Development of Unmanned Aerial Vehicle – Part 2.....	129
	<i>Shahrul Na'im Sidek, A Mushawwir M Khalil, M. Ismail Mohtar</i>	
21	Earthquake Prediction And Monitoring Using Unusual Animal Behavior.....	134
	<i>A. M. Aibinu, W. Astuti, M. J. E. Salami, R. Akmelawati and Asan Gani Muthalif</i>	
22	Development of Automatic Rocking Baby Cradle.....	141
	<i>W. Astuti, N. F. Azlan, A.M. Aibinu, Momoh Jimoh E.Salami and Wahyudi Martono</i>	
23	Electrooculography (EOG)-Controlled Wheelchair.....	149
	<i>Shahrul Na'im Sidek, M. Iqbal Zakaria and A. Ridwan A.Aziz</i>	
24	Conceptual Design of an Intelligent Coconut Dehusking.....	155
	<i>M. J. E. Salami, A. M. Aibinu</i>	
25	An Electrooculogram (EOG) Signal for Wheelchair Motion Control.....	163
	<i>Salmiah Ahmad, Nurul Muthmainnah Mohd Noor</i>	
26	A conceptual Paper on Intelligent Car Battery Monitoring System.....	171
	<i>Abdul Hafiz Bin Sahar, Khairul Azhar Bin Muhamat, M. J. E. Salami, and A. M. Aibinu</i>	
27	GIS-Based Vehicle Traffic Simulation.....	177
	<i>Wahju Sediono</i>	
28	Intelligent Postal Mails Sorter.....	183
	<i>Mohd Arif Faiz Bin Omar, Mohd Zain Bin Ismail, M. J. E. Salami, A. M. Aibinu</i>	
29	Intelligent Wet Scrubber System for Industrial Air Pollution Control.....	188
	<i>Bashir Ahmed Danzomo and Momoh Jimoh E. Salami</i>	
30	Leveraging on Nature for Systems Design.....	194
	<i>Nahrul Khair Alang Md Rashid and Safinaz Kader Mohideen</i>	
31	Natural Ventilation of Yam Storage System.....	199
	<i>Murtala Abdulazeez, M.J.E. Salami, Md. Raisuddin Khan</i>	
32	Self-Repair Capability in Engineering Systems.....	208
	<i>Nahrul Khair Alang Md Rashid and Aous Naji Rasheed</i>	

33	Simulation of Airflow and Temperature Distribution in Yam Storage System	213
	<i>Murtala Abdulazeez, M.J.E. Salami, Md. Raisuddin Khan, Nabeel Adeyemi</i>	
34	Sound Identification in Noisy Environment.....	218
	<i>Nahrul Khair Alang Md Rashid, Nor Hidayati Diana Nordin and Alim Sabur Ajibola</i>	
35	Intelligent CCTV-Based Monitoring System for Kulliyah of Engineering, IIUM.....	225
	<i>M. J. E. Saslami,, A. M. Aibinu and Nur Syahrain binti Mohd Jahini</i>	
36	Virtual Modeling of Two-Wheeled Wheelchair using Msc Visual Nastran 4D.....	231
	<i>Salmiah Ahmad, M. O. Tokhi</i>	

## CHAPTER 32

### Self-Repair Capability in Engineering Systems

Nahrul Khair Alang Md Rashid and Aous Naji Rasheed

Department of Mechatronics Engineering  
International Islamic University Malaysia  
Jalan Gombak, Selangor D.E., Malaysia  
email: nahrul@iium.edu.my

#### 32.1 Introduction

Systems complexity and uncertainty in their operating environments require a new design approach that can make systems capable of self-repair. Systems that are capable of self-repair have potential for improved performance and longer operational lifetimes over conventional systems. Biological systems are equipped with self-repair and self-replication capabilities that enable them to survive. This has inspired research into incorporating some kind of self-repair capability in engineering systems. The tendency to look to nature for solutions, such as in biomimicry, drug discovery, and intelligence in systems

In material sciences, self-healing is already an active area of research. Materials such as plastic, polymers, paints, coatings, ceramics, and concretes have their own self-healing mechanisms. Techniques such as electrohydrodynamics, shape memory effect and nanoparticle migrations have been mentioned as means by which materials can undergo self-healing process [1].

In engineering systems, technical terms, such as fault-tolerant, have been used to portray the ability of a system to continue its operation following a fault due to malfunction of a part or changing environmental conditions. Fault-tolerant, however, is different from self-healing. The former brings the system to a state from which it can resume operation. The latter identifies and eliminates the root cause of the fault and restores the system to its original condition. As most systems comprise hardware and software components, frequently embedded as firmware, a software architecture that enables continuous and automatic monitoring, diagnosis, and remediation of software faults should be part of the self-repair requirements.

Self repair can be viewed from two perspectives:

- (1) functional, and
- (2) system architecture.

From functional perspective, the defective function is repaired or restored whereas from system architecture perspective, the defective component parts are replaced. The underlying principle in both approaches is that the task that the system is to accomplish must be executable irrespective of the means. This is possible as there are many ways of achieving similar tasks. The challenge is in designing the system such that this can be attained. The use of reconfigurable system could be a possible approach that merit further investigation. A combination of both approaches could improve the robustness of a system and enhance its degree of autonomy. Such capability is extremely useful especially in systems that operate remotely where human intervention is not possible such as in space exploration or robots that operate in hazardous or inaccessible environment.