MECHATRONICS BOOK SERIES
CONTROL AND INTELLIGENT SYSTEMS

Momoh Jimoh E. Salami
Abiodun Musa Aibinu
Yasir Mohd Mustafah

IIUM Press
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
MECHATRONICS BOOK SERIES

CONTROL AND INTELLIGENT SYSTEMS

EDITOR

Momoh Jimoh E. Salami
Abiodun Musa Aibusu
Yasir Mohd Mustafah

IIUM Press
Momoh Jimoh E. Salami, Abiodun Musa Abinu, Yasir Mohd Mustafah: Mechatronics Book
Series: Control and Intelligent Systems
Bibliography p.
Includes Index
ISBN


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: iiumpcprinting@yahoo.com
# Table of Content

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Author(s)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFACE</td>
<td></td>
<td></td>
<td>v</td>
</tr>
<tr>
<td>EDITOR</td>
<td></td>
<td></td>
<td>vi</td>
</tr>
<tr>
<td>SECTION 1: INTELLIGENT CONTROL SYSTEM</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Chapter 1</td>
<td>Working Principle and Operating Mode of Atomic Force Microscopy</td>
<td>Iskandar Al-Thani Mahmoud</td>
<td>6</td>
</tr>
<tr>
<td>Chapter 2</td>
<td>Design and Development of controller of Active Power Filter for Industrial Usage part 1</td>
<td>M.M.Rashid, N.A.Ramin and Zahurul</td>
<td>13</td>
</tr>
<tr>
<td>Chapter 3</td>
<td>Design and Development of controller of Active Power Filter for Industrial Usage part 2</td>
<td>M.M.Rashid, N.A.Ramin and Zahurul</td>
<td>21</td>
</tr>
<tr>
<td>Chapter 4</td>
<td>Design and Implementation of Instant Noodles Vending Machine</td>
<td>M.M.Rashid</td>
<td>30</td>
</tr>
<tr>
<td>Chapter 5</td>
<td>Development of Intelligent Belt Conveyor System (Part 1)</td>
<td>M. M. Rashid, Faruok Alliays</td>
<td>39</td>
</tr>
<tr>
<td>Chapter 6</td>
<td>Development of Intelligent Belt Conveyor System</td>
<td>M.M.Rashid, Faruk, M J E Salami</td>
<td>45</td>
</tr>
<tr>
<td>Chapter 8</td>
<td>Design and Prototyping of Inertia Wheel</td>
<td>W. Astuti, A. R. Kasim, M. I. Solihin, A.M. Aibinu, Momoh Jimoh E.Salami and Wahyudi</td>
<td>54</td>
</tr>
<tr>
<td>Chapter 9</td>
<td>Control of Automatic Drilling Machine by PLC</td>
<td>Md Mozasser Rahman, Najiha Md Zain @Abdul Rahman and Mohd Syazwan Bin Jamil</td>
<td>62</td>
</tr>
<tr>
<td>Chapter 10</td>
<td>Automatic Storage and Retrieval System</td>
<td>Abdul Kadir Abdul Jabar Abdul Kadir, M. J. E. Salami and A. M. Aibinu</td>
<td>74</td>
</tr>
<tr>
<td>Chapter 11</td>
<td>Control of Unmanned Underwater Vehicle</td>
<td>Raisuddin Khan, Faried Hasbullah and Masum Billah</td>
<td>80</td>
</tr>
<tr>
<td>Chapter 12</td>
<td></td>
<td></td>
<td>85</td>
</tr>
</tbody>
</table>
Adaptive Sliding Mode Control for 3dof Helicopter
Mostafa A. Hamood, Rini Akmeliawati

Chapter 13 .............................................................................................................................. 93

Backstepping Control of an Autonomous Quadrotor
Norafizah Abas, Rini Akmeliawati

Chapter 14 .............................................................................................................................. 103

Piezoelectric Tube Scanner in Atomic Force Microscope
Iskandar Al-Thani Mahmood

SECTION II : INTELLIGENT CONTROL SYSTEM DESIGN .............................................. 111

Chapter 15 .............................................................................................................................. 112

A Review on Control of Two-Wheeled Wheelchair System
Salmiah Ahmad, M. O. Tokhi

Chapter 16 .............................................................................................................................. 121

A Smart Car Surveillance System using Programmable Logic Controller (PLC)
Siti Fauziah Tohaoa and Mohammad Zafran Haja Mohideen

Chapter 17 .............................................................................................................................. 128

Design of Controller for Elevator Group Using Fuzzy Logic Part 1
M.M. Rashid, Azhar

Chapter 18 .............................................................................................................................. 133

Design of Controller for Elevator Group Using Fuzzy Logic Controller Part 2
M.M. Rashid, Azhar

Chapter 19 .............................................................................................................................. 139

Fuzzy Logic-based Intelligent Control of Flexible Link Manipulator
Ismaila B. Tijani and Rini Akmeliawati

Chapter 20 .............................................................................................................................. 148

EEG based robot control
A. Khoshidtalab and M. J. E. Salami

Chapter 21 .............................................................................................................................. 158

Visual-Based Intelligent Solar Tracking System
Rini Akmeliawati, Samir A. Abdul Kareem, Riza Muhida

SECTION III: INTELLIGENT SYSTEM DESIGN ................................................................. 172

Chapter 22 .............................................................................................................................. 173

Intelligent Air-conditioning System
Amir A. Shafiee, Raisuddin Khan, H. Al-haieaid M. Ebrahim

Chapter 23 .............................................................................................................................. 179

An Intelligent Car Surveillance System: Design and Tools Selection
Siti Fauziah Tohao’ and Mohammad Zafran Haja Mohideen

Chapter 24 .............................................................................................................................. 185

Automatic Pipe Bursting Monitoring System
M. J. E. Salami. Syed Ahmed @ Hla Moe Win
Chapter 42
Active Suspension System: Part 2 - Controller Design and Simulation

Ayman S.I. Elzubair a, Asan G. A. Muthalif b, Aiman O. Bajaber c

Department of Mechatronics Engineering, International Islamic University Malaysia
Jalan Gombak, 53100, Kuala Lumpur, Malaysia
aaymanalzupair@yahoo.com, basan@iium.edu.my, cBajaber2020@gmail.com

42.1 Introduction
Keeping a constant distance between the chassis and wheel thereby reducing vibration output to vehicle’s body is one of the main objectives of a suspension system. Typically, there are three ways to implement suspension system: passive, active and semi-active. Passive suspension system depends on springs and absorbers while the active uses a feedback control system with actuators and sensors. Semi-active system surpasses active one with regards to size and power required. It works as either passive or active suspension since the passive components are not removed but combined with the active parts. Greater degree of energy absorption can be achieved under straight-line driving, making for a smoother ride, while the suspension can automatically stiffen when the car begins to turn, and aids handling – effectively combining the best of both worlds.

Fig. 42.1: A typical passive suspension system.

42.1.1 Typical Controllers Designed For Semi-Active Suspension

Proportional–integral–derivative (PID) controller: A PID controller is a standard feedback loop component in industrial control applications. It measures an “output” of a process and controls an “input,” with a goal of maintaining the output at a target value which called the "set point". PID can be described as a set of rules with which precise regulation of closed-loop feedback control system is obtained, shown in Fig. 42.2. Proportional, integral and derivative parameters are $K_P$, $K_I$, $K_D$. Each of the three control functions is governed by a user-defined parameter. While PID is mostly used in SISO systems and yields superior results, this is not the case for MIMO systems. That lead us to look for an alternative controller that can be easily used for such systems.