



SMART CONTROL SOLUTIONS FOR ROBOTIC AND REHABILITATION INDUSTRIES

**EDITORS
ANITA AHMAD
NOORHAZIRAH SUNAR**

SMART CONTROL SOLUTIONS FOR ROBOTIC AND REHABILITATION INDUSTRIES

This book introduces various topics related to smart control. The topics cover researches and studies of smart control usage from various fields such as robotic and rehabilitation industries. The topics describe the theory, research work, circuit design, experiments and system measurement. The presented topics have been selected to prepare engineering students to use smart control in various applications. This book is generally suitable as an accompaniment to laboratory sessions at engineering institutions.



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Penerbit
UTM Press



ISBN 978-983-52-2111-8



9 789835 221118

RM50.00

**SMART CONTROL
SOLUTIONS FOR ROBOTIC
AND REHABILITATION
INDUSTRIES**

SMART CONTROL SOLUTIONS FOR ROBOTIC AND REHABILITATION INDUSTRIES

**EDITORS
ANITA AHMAD
NOORHAZIRAH SUNAR**



www.penerbit.utm.my

2024

First Edition 2024
© ANITA AHMAD & NOORHAZIRAH SUNAR 2024

Hak cipta terpelihara. Tiada dibenarkan mengeluarkan mana-mana bahagian artikel, ilustrasi, dan isi kandungan buku ini dalam apa jua bentuk dan cara apa jua sama ada dengan cara elektronik, fotokopi, mekanikal, atau cara lain sebelum mendapat izin bertulis daripada Timbalan Naib Canselor (Penyelidikan & Inovasi), Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor Darul Ta'zim, Malaysia. Perundingan tertakluk kepada perkiraan royalti atau honorarium.

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical including photocopying, recording, or any information storage and retrieval system, without permission in writing from Deputy Vice-Chancellor (Research & Innovation), Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor Darul Ta'zim, Malaysia. Negotiation is subject to royalty or honorarium estimation.

Editor: **ANITA AHMAD & NOORHAZIRAH SUNAR**
Editor Penyelaras/*Acquisition Editor*: **MAZLAN SAID**
Pereka Kulit /*Cover Designer*: **NUR'ATIQA ARSHAD**

Diatur huruf oleh /*Typeset by*:
ANITA AHMAD & NOORHAZIRAH SUNAR
Faculty of Electrical Engineering
UNIVERSITI TEKNOLOGI MALAYSIA
81310 UTM Johor Bahru
Johor Darul Ta'zim, MALAYSIA

Diterbitkan di Malaysia oleh/
Published in Malaysia by:
PENERBIT UTM PRESS
UNIVERSITI TEKNOLOGI MALAYSIA
81310 UTM Johor Bahru
Johor Darul Ta'zim, MALAYSIA
(PENERBIT UTM ahli MAJLIS
PENERBITAN ILMIAH MALAYSIA –
MAPIM dan MABOPA
dengan no. keahlian 9101)

Dicetak di Malaysia oleh/
Printed in Malaysia by:
JASAMAX ENTERPRISE
No.16, Jalan Kebudayaan 2,
Taman Universiti,
81310 Skudai Johor,
MALAYSIA



Cataloguing-in-Publication Data
Perpustakaan Negara Malaysia
A catalogue record for this book is available from the
National Library of Malaysia
ISBN 978-983-52-2111-8

CONTENTS

<i>Contributors</i>	<i>vii</i>
<i>Preface</i>	<i>ix</i>
CHAPTER 1 SMART CONTROL IN SOLUTION	1
<i>Anita Ahmad and Noorhazirah Sunar</i>	
CHAPTER 2 MODELLING OF SMART CONTROL: UNMANNED AERIAL VEHICLES QUADCOPTER	9
<i>Tan Kai Sheng and Mohd Fuaad Rahmat</i>	
CHAPTER 3 REAL-TIME SMART CONTROL GRID SYSTEM	45
<i>Khaled Ahmed Khalil Abdelfttah Khalil and Sophan Wahyudi Nawawi</i>	
CHAPTER 4 SMART CONTROL FOR CONTINUOUS PASSIVE MOTION FOR KNEE REHABILITATION	61
<i>Muhammad Alif Haikal Khairul Anuar and Anita Ahmad</i>	
CHAPTER 5 SMART CONTROL FOR WARNING SYSTEM: WATER TREATMENT USING MAGNETIC MICROPARTICLE	85
<i>Matthew Mark Cyrinus and Khairul Hamimah Abas</i>	

CHAPTER 6	SMART TRASH BIN CONTROL TO PREVENT ANIMAL DISTURBANCE	99
	<i>Raveneswaran Subramaniam, Siti Zarina Mohd Muji, and Ruzairi Abdul Rahim</i>	
CHAPTER 7	SMART CONTROL FOR PIPELINE INSPECTION ROBOT	109
	<i>Aisyah Mohd Akram and Herlina Abdul Rahim</i>	
INDEX		137

CONTRIBUTORS

Aisyah Mohd Akram *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Anita Ahmad *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Herlina Abdul Rahim *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Khairul Hamimah Abas *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Khaled Ahmed Khalil Abdelfttah Khalil *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Matthew Mark Cyrinus *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Mohd Fuaad Rahmat *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Muhammad Alif Haikal Khairul Anuar *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Noorhazirah Sunar *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Raveneswaran Subramaniam *Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, Batu Pahat*

Ruzairi Abdul Rahim *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Siti Zarina Mohd Muji *Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, Batu Pahat*

Sophan Wahyudi Nawawi *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Tan Kai Sheng *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

PREFACE

This book introduces various topics related to smart control. The topics cover researches and studies of smart control usage from various fields such as robotic and rehabilitation industries. The topics describe the theory, research work, circuit design, experiments and system measurement. The presented topics have been selected to prepare engineering students to use smart control in various applications.

In addition to serving as a valuable resource for students, this book also caters to the needs of educators, researchers, and industry professionals. For educators, the book offers a structured framework for teaching smart control concepts and applications, making it an excellent addition to engineering curricula. For researchers, it provides insights into the latest advancements and trends in the field, inspiring further exploration and innovation. For industry professionals, the book serves as a practical guide for implementing smart control solutions to address specific challenges and improve system performance.

In summary, this book is a comprehensive guide to the theory, research, design, and application of smart control systems. It bridges the gap between theoretical understanding and practical application, empowering readers to harness the potential of smart control technologies. Additionally, it serves as a practical accompaniment to laboratory sessions at engineering institutions, reinforcing hands-on learning and skill development.

Anita Ahmad

Noorhazirah Sunar

Universiti Teknologi Malaysia

2024

