

# Home-Made PIC 16F877 Microcontroller-Based Temperature Control System for Learning Automatic Control

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**ABSTRACT:** A closed-loop temperature control system, which is composed of a thermal plant and a controller, has been developed to support undergraduate students in learning automatic control delivered in the Special Topics in Instrumentation Physics course. The thermal plant was made from a plastic box covering a lamp and a fan, which heats and cools the air in the plastic box, respectively, as well as a temperature sensor. The controller with a proportional control action was realized by employing the PIC 16F877 microcontroller. The control signal updates pulse-width modulators (PWMs) in which driver circuits turn on or off the lamp and the fan. A mathematical model of the closed-loop control system was derived and a theoretical transient response was then obtained. It is found that the experimental transient responses were always much lower than the set point and the steady-state errors were high for the proportional sensitivity ( $K_p$ ) lower than 10. For  $K_p$  higher than 10, the transient responses tend to approach the set point to cause small steady-state errors. These characteristics are consistent with the theoretical transient response. Further examination revealed that the closed-loop system is a higher order system due to the action of the PWMs and the driver circuits. © 2010 Wiley Periodicals, Inc. *Comput Appl Eng Educ* 19: 10–17, 2011. View this article online at [www.interscience.wiley.com](http://www.interscience.wiley.com). DOI: 10.1002/cae.20283

**Keywords:** control system; instrumentation physics; microcontroller; proportional; thermal plant

## INTRODUCTION

Control systems courses are traditionally offered by Electrical and Mechanical Engineering Departments [1–3]. Few departments outside electrical and mechanical engineering disciplines present courses on control systems in their curricula. Several Chemical Engineering Departments at several universities in USA have introduced modern control systems teaching to their undergraduate students [4,5]. The teaching of modeling, simulation, and control to students in the Department of Applied Physics, Faculty of Physics at the University of La Laguna, Spain, has been done [6]. School of Physics and Astronomy at the University of Nottingham in the United Kingdom has changed the curriculum of the second year practical laboratory course to implement Matlab in teaching undergraduate students about instrument control techniques [7].

Physics Study Program at the Faculty of Mathematics and Natural Sciences of Institut Teknologi Bandung offers some elective courses in the fourth year of undergraduate program. One of the elective courses is FI4172 Special Topics in Instrumentation Physics, which is a 3-credit unit course. It contains lectures on advanced instrumentation systems including instruments for characterizing materials, nuclear and Biophysics instruments as well as instruments in geophysics because the Physics Study Program has several subprograms such as Physics of Electronic, Magnetic and Photonic Materials, Nuclear Physics, Biophysics, and Geophysics. A very important topic delivered in the course is automatic control because it is easily found in the instruments.

In order to support theoretical concepts on automatic control that were explained by a lecturer in classroom, laboratory works that can be done by students must be provided. By executing the laboratory works, it is hoped that the students can learn the theoretical concepts easily and therefore grasp them more. This is reinforced by the survey done by Rickel [8], who found that students retain 25% of what they hear, 45% of what they hear and see, and 70% if they use the “learning-by-doing” method.

A personal computer or microcontroller has been used in learning control with laboratory scale models [9–11]. Pesto [12]

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# The Automated Pic Microcontroller Based Temperature Control

**Anirban Mitra, Jayanta Mondal, Anirban  
Das**



### **The Automated Pic Microcontroller Based Temperature Control:**

**Microcontroller-Based Temperature Monitoring and Control** Dogan Ibrahim, 2002-10-08 Provides practical guidance and essential theory making it ideal for engineers facing a design challenge or students devising a project Includes real world design guides for implementing a microcontroller based control systems Requires only basic mathematical and engineering background as the use of microcontrollers is introduced from first principles Engineers involved in the use of microcontrollers in measurement and control systems will find this book an essential practical guide providing design principles and application case studies backed up with sufficient control theory and electronics to develop their own systems It will also prove invaluable for students and experimenters seeking real world project work involving the use of a microcontroller Unlike the many introductory books on microcontrollers Dogan Ibrahim has used his engineering experience to write a book based on real world applications A basic mathematical and engineering background is assumed but the use of microcontrollers is introduced from first principles Microcontroller Based Temperature Monitoring and Control is an essential and practical guide for all engineers involved in the use of microcontrollers in measurement and control systems The book provides design principles and application case studies backed up with sufficient control theory and electronics to develop your own systems It will also prove invaluable for students and experimenters seeking real world project work involving the use of a microcontroller Techniques for the application of microcontroller based control systems are backed up with the basic theory and mathematics used in these designs and various digital control techniques are discussed with reference to digital sample theory The first part of the book covers temperature sensors and their use in measurement and includes the latest non invasive and digital sensor types The second part covers sampling procedures control systems and the application of digital control algorithms using a microcontroller The final chapter describes a complete microcontroller based temperature control system including a full software listing for the programming of the controller

**Fundamentals of Embedded Systems: Design and Applications** Mr.S.Anbarasan, 2025-09-09 Author Mr S Anbarasan Assistant Professor Department of Electronics and Communication Engineering Tittagudi Sengunthar Engineering College Tholudur Tamil Nadu India

**Proceedings of the 2nd International Conference on Computational and Bio Engineering** S. Jyothi, D. M. Mamatha, Yu-Dong Zhang, K. Srujan Raju, 2021-09-27 This book presents the peer reviewed proceedings of the 2nd International Conference on Computational and Bioengineering CBE 2020 jointly organized in virtual mode by the Department of Computer Science and the Department of BioScience Sericulture Sri Padmavati Mahila Visvavidyalayam Women s University Tirupati Andhra Pradesh India during 4 5 December 2020 The book includes the latest research on advanced computational methodologies such as artificial intelligence data mining and data warehousing cloud computing computational intelligence soft computing image processing Internet of things cognitive computing wireless networks social networks big data analytics machine learning network security computer networks and communications bioinformatics

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**Programming and Customizing the PIC Microcontroller** Michael Predko, 1998 Microchip's PIC microcontroller is rapidly becoming the microcontroller of choice throughout the world. This hands-on tutorial and disk provide everything electronic designers, engineers, and advanced hobbyists need to tap the power of this invaluable chip: the most complete description of PIC available; over 30 experiments and ten complete PIC application projects; a full set of DOS and Windows PIC development tools; reusable source code; and a complete PIC application program that can easily be tailored to the reader's needs.

**Intelligent Computing and Optimization** Pandian Vasant, Vladimir Panchenko, Elias Munapo, Gerhard-Wilhelm Weber, J. Joshua Thomas, Rolly Intan, Mohammad Shamsul Arefin, 2024-12-26 This book of Springer Nature is another proof of Springer's outstanding and greatness on the lively interface of Smart Computational Optimization, Green Infrastructure, Innovative Modeling, and Deep Learning Architectures. It is a Master Piece of what our community of Academics and Experts can provide when an Interconnected Approach of Joint Mutual and Meta Learning is supported by Holistic Operational Research and Experience of the World Leader Springer Nature. The 7th edition of International Conference on Intelligent Computing and Optimization took place at Baitong Hotel Resort on October 26-27, 2023, with tremendous support from the global research scholars across the planet. Objective was to celebrate Global Research Quality with Compassion and Wisdom with researchers, scholars, experts, and investigators in Intelligent Computing and Optimization across the globe to share knowledge, experience, and innovation: a marvelous opportunity for discourse and mutuality by novel research invention and creativity. This proceedings book of the 7th ICO 2023 is published by Springer Nature Creativity Label of Inspiration.

**Smart and Secure Embedded and Mobile Systems** Jorge Marx Gómez, Anael Elikana Sam, Devotha Godfrey Nyambo, 2024-06-29 This book gathers a selection of research papers that delve into the field of smart systems covering a wide range of applications in transportation, agriculture, healthcare, energy management, and more. Emphasizing the fusion of intelligence and security, they reveal how advanced embedded and mobile systems are paving the way for a smarter and safer future. The book presents peer-reviewed research articles from the First International Conference on Embedded and Mobile Systems (ICTA-EMOS) which was held on November 24th-25th, 2022, in Arusha, Tanzania. The book showcases the remarkable potential of advanced technologies in shaping a smarter and more secure world, addressing topics such as transportation and mobility solutions, smart manufacturing, and agriculture, ICT infrastructure, and resource management, healthcare, and energy management, system integration, and control, and solutions for innovation and monitoring.

**AI, Edge and IoT-based Smart Agriculture** Ajith Abraham, Sujata Dash, Joel J.P.C. Rodrigues, Biswaranjan Acharya, Subhendu Kumar Pani, 2021-11-10 AI, Edge and IoT Smart Agriculture integrates applications of IoT, edge computing, and data analytics for sustainable agricultural development and introduces Edge of Things-based data analytics and IoT for predictability of crop, soil, and plant disease occurrence for improved sustainability and increased profitability. The book also addresses precision irrigation.

precision horticulture greenhouse IoT livestock monitoring IoT ecosystem for agriculture mobile robot for precision agriculture energy monitoring storage management and smart farming The book provides an overarching focus on sustainable environment and sustainable economic development through smart and e agriculture Providing a medium for the exchange of expertise and inspiration contributions from both smart agriculture and data mining researchers around the world provide foundational insights The book provides practical application opportunities for the resolution of real world problems including contributions from the data mining data analytics Edge of Things and cloud research communities working in the farming production sector The book offers broad coverage of the concepts themes and instruments of this important and evolving area of IOT based agriculture Edge of Things and cloud based farming Greenhouse IOT mobile agriculture sustainable agriculture and big data analytics in agriculture toward smart farming Integrates sustainable agriculture Greenhouse IOT precision agriculture crops monitoring crops controlling to prediction livestock monitoring and farm management Presents data mining techniques for precision agriculture including weather prediction plant disease prediction and decision support for crop and soil selection Promotes the importance and uses in managing the agro ecosystem for food security Emphasizes low energy usage options for low cost and environmental sustainability

**Advances in Manufacturing Processes and Smart Manufacturing Systems** Denni Kurniawan, Fethma M.

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Suresh Chandra Satapathy, K. Srujan Raju, Jyotsna Kumar Mandal, Vikrant Bhateja, 2015-09-03 The book is about all aspects of computing communication general sciences and educational research covered at the Second International Conference on Computer Communication Technologies held during 24 26 July 2015 at Hyderabad It hosted by CMR Technical Campus in association with Division V Education Research CSI India After a rigorous review only quality papers are selected and included in this book The entire book is divided into three volumes Three volumes cover a variety of topics which include medical imaging networks data mining intelligent computing software design image processing mobile computing digital signals and speech processing video surveillance and processing web mining wireless sensor networks circuit analysis fuzzy systems antenna and communication systems biomedical signal processing and applications cloud computing embedded systems applications and cyber security and digital forensic The readers of these volumes will be highly benefited from the technical contents of the topics Proceedings of the 2009 International

Conference on Signals, Systems and Automation (ICSSA 2009) Himanshu Soni, 2010-04-30 This book is a collection of papers from the 2009 International Conference on Signals Systems and Automation ICSSA 2009 The conference at a glance Pre conference Workshops Tutorials on 27th Dec 2009 Five Plenary talks Paper Poster Presentation 28 29 Dec 2009 Demonstrations by SKYVIEW Inc SLS Inc BSNL Baroda Electric Meters SIS On line paper submission facility on website 200 papers are received from India and abroad Delegates from different countries including Poland Iran USA Delegates from 16 states of India Conference website is seen by more than 3000 persons across the world 27 countries and 120 cities *Plant Intelligent Automation and Digital Transformation Volume II* Swapan Basu, 2024-08-11 Plant Intelligent Automation and Digital Transformation Volume II Control and Monitoring Hardware and Software is an expansive four volume collection that reviews every major aspect of the intelligent automation and digital transformation of power process and manufacturing plants including specific control and automation systems pertinent to various power process plants using manufacturing and factory automation systems The book reviews the key role of management Information systems MIS HMI and alarm systems in plant automation in systemic digitalization covering hardware and software implementations for embedded microcontrollers FPGA and operator and engineering stations Chapters address plant lifecycle considerations inclusive of plant hazards and risk analysis Finally the book discusses industry 4 0 factory automation as a component of digitalization strategies as well as digital transformation of power plants process plants and manufacturing industries Reviews supervisory control and data acquisitions SCADA systems for real time plant data analysis Provides practitioner perspectives on operational implementation including human machine interface operator workstation and engineering workstations Covers alarm and alarm management systems including lifecycle considerations Fully covers risk analysis and assessment including safety lifecycle and relevant safety instrumentation **Proceedings of the Multi-Conference 2011** Himanshu B. Soni, Apurva Shah, 2011-06-06 The International Conference on Signals Systems and Automation ICSSA 2011 aims to spread awareness in the research and academic community regarding cutting edge technological advancements revolutionizing the world The main emphasis of this conference is on dissemination of information experience and research results on the current topics of interest through in depth discussions and participation of researchers from all over the world The objective is to provide a platform to scientists research scholars and industrialists for interacting and exchanging ideas in a number of research areas This will facilitate communication among researchers in different fields of Electronics and Communication Engineering The International Conference on Intelligent System and Data Processing ICISD 2011 is organized to address various issues that will foster the creation of intelligent solutions in the future The primary goal of the conference is to bring together worldwide leading researchers developers practitioners and educators interested in advancing the state of the art in computational intelligence and data processing for exchanging knowledge that encompasses a broad range of disciplines among various distinct communities Another goal is to promote scientific information interchange between researchers

developers engineers students and practitioners working in India and abroad      **Medical Internet of Things** Anirban Mitra, Jayanta Mondal, Anirban Das, 2021-10-28 In recent years the Medical Internet of Things MIoT has emerged as one of the most helpful technological gifts to mankind With the incredible development in data science big data technologies IoT and embedded systems it is now possible to collect a huge amount of sensitive and personal data compile it and store it through cloud or edge computing techniques However important concerns remain about security and privacy the preservation of sensitive and personal data and the efficient transfer storage and processing of MIoT based data Medical Internet of Things Techniques Practices and Applications is an attempt to explore new ideas and novel techniques in the area of MIoT The book is composed of fifteen chapters discussing basic concepts issues challenges case studies and applications in MIoT This book offers novel advances and applications of MIoT in a precise and clear manner to the research community to achieve in depth knowledge in the field This book will help those interested in the field as well as researchers to gain insight into different concepts and their importance in multifaceted applications of real life This has been done to make the book more flexible and to stimulate further interest in the topic Features A systematic overview of concepts in Medical Internet of Things MIoT is included Recent research and some pointers on future advancements in MIoT are discussed Examples and case studies are included It is written in an easy to understand style with the help of numerous figures and datasets This book serves as a reference book for scientific investigators who are interested in working on MIoT as well as researchers developing methodology in this field It may also be used as a textbook for postgraduate level courses in computer science or information technology      **Security and Trust Issues in Internet of Things** Sudhir Kumar

Sharma, Bharat Bhushan, Bhuvan Unhelkar, 2020-12-02 The purpose of this edited book is to present and showcase the basic fundamentals applications and integration of both IoT and Blockchain The trend of applying Blockchain to IoT is rapidly growing because it helps to overcome various challenges faced by IoT from smart manufacturing to unmanned aerial vehicles This book aims to showcase the basics of both IoT and Blockchain as well as the integration and challenges for existing practitioners This book initiates conversations among technologists engineers scientists and clinicians to synergize their efforts in producing low cost high performance highly efficient deployable IoT systems This book is theory based and is useful for engineers from various disciplines including industrial engineering computer science electronics telecommunications electrical agricultural and cybersecurity along with researchers professionals and students

Intelligent Systems for Social Good Shyamapada Mukherjee, Naresh Babu Muppalaneni, Sukriti Bhattacharya, Ashok Kumar Pradhan, 2022-06-11 This book highlights the connections between two technologies artificial intelligence AI and Internet of things IoT It presents the application of these two technologies to solve various societal problems related to healthcare agriculture green environment renewable energies smart cities etc Each chapter in this book presents novel solutions to these problems along with the challenges in the application of AI and IoT to solve them It discusses the adverse

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**Physical System and IoT in Smart Automation and Robotics** Krishna Kant Singh,Anand Nayyar,Sudeep Tanwar,Mohamed Abouhawwash,2021-05-04 Cyber Physical Systems CPS integrate computing and communication capabilities by monitoring and controlling the physical systems via embedded hardware and computers This book brings together new and futuristic findings on IoT Cyber Physical Systems and Robotics leading towards Automation and solving issues of various critical applications in Real time The book initially overviews the concepts of IoT IIoT and Cyber Physical Systems followed by various critical applications and discusses the latest designs and developments that provide common solutions for the convergence of technologies In addition the book specifies methodologies algorithms and other relevant architectures in various fields that include Automation Robotics Smart Agriculture and Industry 4 0 The book is intended for practitioners enterprise representatives scientists students and Ph D Scholars in hopes of steering research further towards cyber physical systems design and development and implementation across various domains Additionally this book can be used as a secondary reference or rather one stop guide by professionals for real life implementation of cyber physical systems The book highlights A Critical Coverage of various domains IoT Cyber Physical Systems Industry 4 0 Smart Automation and related critical applications Advanced elaborations for target audiences to understand the conceptual methodology and future directions of cyber physical systems and IoT An approach towards Research Orientations to enable researchers to point out areas and scope for implementation of Cyber Physical Systems in several domains for better productivity      **ARM-Based Microcontroller Multitasking Projects** Dogan Ibrahim,2020-05-14 Most microcontroller

based applications nowadays are large complex and may require several tasks to share the MCU in multitasking applications Most modern high speed microcontrollers support multitasking kernels with sophisticated scheduling algorithms so that many complex tasks can be executed on a priority basis ARM based Microcontroller Multitasking Projects Using the FreeRTOS Multitasking Kernel explains how to multitask ARM Cortex microcontrollers using the FreeRTOS multitasking kernel The book describes in detail the features of multitasking operating systems such as scheduling priorities mailboxes event flags semaphores etc before going onto present the highly popular FreeRTOS multitasking kernel Practical working real time projects using the highly popular Clicker 2 for STM32 development board which can easily be transferred to other



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**Recent Trends in Image Processing and Pattern Recognition** K. C. Santosh,Ravindra S.

Hegadi,2019-07-16 This three book set constitutes the refereed proceedings of the Second International Conference on Recent Trends in Image Processing and Pattern Recognition RTIP2R 2018 held in Solapur India in December 2018 The 173 revised full papers presented were carefully reviewed and selected from 374 submissions The papers are organized in topical sections in the tree volumes Part I computer vision and pattern recognition machine learning and applications and image processing Part II healthcare and medical imaging biometrics and applications Part III document image analysis image analysis in agriculture and data mining information retrieval and applications

Precision Agriculture ,2024-09-04 Precision agriculture has revolutionized the way crops are grown and managed by utilizing advanced technologies to optimize farm production reduce waste and improve environmental sustainability Emerging technologies in precision agriculture including edge computing 5G communication the Internet of Things artificial intelligence digital twins blockchain big data analytics robotics and augmented reality are making significant contributions to the growth and development of this field This book explores the latest advancements achievements and opportunities associated with these technologies in terms of improved efficiency reduced labor costs and enhanced safety as well as the challenges involved in the implementation such as high costs of adoption regulations and the need for skilled personnel Each chapter presents research reports describing new methods and perspectives in precision agriculture applications based on innovative tools from basic and applied research This book can serve both the academic community and farmers by demonstrating how modern technologies are advancing precision agriculture to the next level

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## **Table of Contents The Automated Pic Microcontroller Based Temperature Control**

1. Understanding the eBook The Automated Pic Microcontroller Based Temperature Control
  - The Rise of Digital Reading The Automated Pic Microcontroller Based Temperature Control
  - Advantages of eBooks Over Traditional Books
2. Identifying The Automated Pic Microcontroller Based Temperature Control
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an The Automated Pic Microcontroller Based Temperature Control
  - User-Friendly Interface
4. Exploring eBook Recommendations from The Automated Pic Microcontroller Based Temperature Control
  - Personalized Recommendations
  - The Automated Pic Microcontroller Based Temperature Control User Reviews and Ratings

- The Automated Pic Microcontroller Based Temperature Control and Bestseller Lists
- 5. Accessing The Automated Pic Microcontroller Based Temperature Control Free and Paid eBooks
  - The Automated Pic Microcontroller Based Temperature Control Public Domain eBooks
  - The Automated Pic Microcontroller Based Temperature Control eBook Subscription Services
  - The Automated Pic Microcontroller Based Temperature Control Budget-Friendly Options
- 6. Navigating The Automated Pic Microcontroller Based Temperature Control eBook Formats
  - ePub, PDF, MOBI, and More
  - The Automated Pic Microcontroller Based Temperature Control Compatibility with Devices
  - The Automated Pic Microcontroller Based Temperature Control Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of The Automated Pic Microcontroller Based Temperature Control
  - Highlighting and Note-Taking The Automated Pic Microcontroller Based Temperature Control
  - Interactive Elements The Automated Pic Microcontroller Based Temperature Control
- 8. Staying Engaged with The Automated Pic Microcontroller Based Temperature Control
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers The Automated Pic Microcontroller Based Temperature Control
- 9. Balancing eBooks and Physical Books The Automated Pic Microcontroller Based Temperature Control
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection The Automated Pic Microcontroller Based Temperature Control
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine The Automated Pic Microcontroller Based Temperature Control
  - Setting Reading Goals The Automated Pic Microcontroller Based Temperature Control
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of The Automated Pic Microcontroller Based Temperature Control
  - Fact-Checking eBook Content of The Automated Pic Microcontroller Based Temperature Control
  - Distinguishing Credible Sources

13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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