机器人控制技术 Robot Control Technology

- 教师介绍 Faculty

Prof. Zhengcai 曹政才

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Research Interests

1.Innovation and Optimization of Intelligent Robots Configurational Design
2.Theory and method of Autonomous Behavior of advanced robot
3.Intelligent Planning and Scheduling theory
4.Theory and Technology of Intelligent Operational Optimization

Education Experience

1.09/2001~09/2005: Ph.D., State Key Laboratory of Robotics and System, Harbin Institute of Technology(HIT)
2.09/1999~07/2001: M.S., Institute of Small and Special Electrical Machines and Control, Harbin Institute of Technology(HIT)
3.09/1992~07/1996: B.S., Heilongjiang University of Science and Technology

Working Experience

1.09/2015~present: Vice-dean, College of Information Science & Technology, BUCT
2.03/2014~03/2015: Visiting Scholar, King's College London(KCL)
3.07/2012~present: Doctoral supervisor, College of Information Science & Technology, BUCT
4.01/2012~present: Professor, College of Information Science & Technology, BUCT
5.07/2008~12/2011:Associate Professor, College of Information Science & Technology, BUCT
6.01/2006~06/2008: Postdoctoral, Post-doctoral Research Center of Control Science and Engineering, Tongji University

Teaching Courses

Graduate Courses:
1.Scheduling and decision making of production process
2.Robot control technology

Undergraduate Courses：
1.Computer control system
2.Lectures of Academic Frontiers

Academic Activities

1. Member of Technical Committee on Intelligent Automation
2. Member of Technical Committee on Discrete System Simulation
3. Member of Technical Committee on Intelligent Robots
4. Member of Technical Committee on Intelligent Optimization
5. Member of Technical Committee on CAD&CG
6. Member of Technical Committee on Robot of Chinese Society of Astronautics
7. Member of Technical Committee on Natural Computing and Digital Smart City

Projects

1. 01/2016~12/2019: National Science Foundation of China (Grant No. 51575034): Variable stiffness snake-like rescue robot mechanism design and compliance control research for terrain self-adaption
2. 01/2014~12/2017: National Science Foundation of China (Grant No. 51375038): Dynamic scheduling theory and method for semiconductor manufacturing process orienting incomplete information
3. 01/2014~12/2016: Research Fund for the Doctoral Program of Higher Education of China (Grant No. 20130010110009): Feature analysis and data driven based dynamic scheduling method for semiconductor wafer fabrication
4. 01/2015~12/2016：the Open Project Program of the State Key Lab of CAD&CG (Grant No. A1516), Zhejiang University：Research on autonomous environment cognition and robust servo problem of robot based on vision
5. 06/2014~05/2016：the Open Project Program of the Key Laboratory of the Symbol computation and Knowledge Engineer, Ministry of Education.(Grant No. 93K172014K05): Dynamic scheduling method based on multi-agent for semiconductor wafer fabrication
6. 01/2014~12/2015: State Key Laboratory of Robotics and System, Harbin Institute of Technology (Grant No. SKLRS-2013-ZD-03): Research on variable stiffness snake-like robot with parallel driven wheel orienting rescue mission

Publications

(1).Cao Zhengcai, Yin Longjie, Fu Yili, Jian S Dai. Adaptive dynamic surface control for vision-based stabilization of an uncertain electrically driven Nonholonomic mobile robot.

Robotica, 2015, 1-19. (doi: 10.1017/S0263574714001581).
(2).Cao Zhengcai, Ma Fengle, Fu Yili. A Scale Invariant Interest Point Detector in Gabor Based Energy Space. Acta Automatica Sinica,2014, 40(10): 2356-2363.
(3).Cao Zhengcai, Ma Fengle, Jian S Dai, Zhan Jian. A Gabor Based Fast Interest Point Detector for Image-Based Robot Visual Servo Control. IEEE Conference on Automation Science and Engineering, 2014, 883-888.
(4).Cao Zhengcai, Weng Hyping, Fu Yili. Mobile Robot Localization Based on Particle Filter with Re-Sampling from the Heuristic Perspective. 2014 IEEE/SICE International Symposium on System Integration, 2014, 198-203.
(5).Cao Zhengcai, Chen Song, Jian S Dai. Robot Localization and Distributed Semantic Mapping Based on QR Code and RFID Technology, 2014 IEEE/SICE International Symposium on System Integration, 2014, 204-209.
(6).Cao Zhengcai, Yin Longjie, Fu Yili. Vision-based Stabilization of Nonholonomic Mobile Robots by Integrating Sliding-mode Control and Adaptive Approach. Chinese Journal of Mechanical Engineering,2013, 26(1):21-28.
(7).Cao Zhengcai, Yin Longjie, Fu Yili. Visual Servo Stabilization of Nonholonomic Mobile Robot Based on Epipolar Geometry and 1D Trifocal Tensor. Chinese Journal of Electronics,2013, 22(4): 729-734.
(8).Cao Zhengcai, Yin Longjie, Fu Yili. Predictive Control for Visual Servo Stabilization of Nonholonomic Mobile Robots. Acta Automatica Sinica, 2013, 39(8): 1238-1245.
(9).Cao Zhengcai, Peng Yazhen, LI Bo, Liu Min. A BDR and ANFIS Integrated Dynamic Scheduling Algorithm for Semiconductor Wafer Fabrication, Acta Electronica Sinica，2015,43(10);2082-2087.(in Chinese)
(10). Cao Zhengcai, Li Bo, Liu Min, Zhang Jie. Approach to Proton Exchange Membrane Fuel Cell Modeling Based on Dynamic Neural Networks. Acta Electronica Sinica, 2014, 42(1):102-106(in Chinese)
(11).Jijie Deng, Zhengcai Cao, Min Liu. A bottleneck prediction and rolling horizon scheme combined dynamic scheduling algorithm for semiconductor wafer fabrication. IEEE 11th International Conference on Networking, Sensing and Control, 2014: 58-63.
(12).Cao Zhengcai, Zhao Huidan, Wang Yongji. ANFIS and SA based approach to prediction, scheduling, and performance evaluation for semiconductor wafer fabrication. Chinese Journal of Electronics, 2013, 22(1): 25-30.

- **课程介绍 About Course**

  Robot control technology is an important course to train students to acquire knowledge of Robotics, which could also train the ability of solving problems and innovation with obtained knowledge. This course introduces the development of robotics, robot kinematics, robot dynamics, robot control, robot planning, environmental sensing method, information processing of sensors, task-oriented robot design and so on, and focuses on the ability of students to analyze and solve problems. Robot control technology is a module course in Control Subject; it needs integrated using of related knowledge and skills, combined with a variety of practical teaching. The course plays an important role in the industrial engineering teaching programs.

- **课程大纲 Syllabus**

Course title: Robot control technology

Teacher： Prof. Cao Zhengcai

Course Code: EE565

Period: 32

Credit hour: 2.0

Preparatory course: Principles of Automatic Control、Principles and Applications of Microcontroller、Electrical Information Science and Technology

Textbook: Self-edition

References:

[1] Tongying Guo，Dong An. Robotics and Intelligent Control, Post&Telecom Press，2014.8

[2] Huiying Dong，Robotic principles and technology, Tsinghua University Press,2014.9

[3] Jifeng Liu, Fundamentals of Robot Techniques, Higher Education Press,2012.12

[4] Ming Li，JIQIREN, Shanghai Science and Technology Press，2012.01

[5] J. J. ((Craig, John J.)), Introduction to robotics mechanics and control, Mechanical Industry Press, 2006

Content and Arrangements:

Chapter 1 Introduction

The research object, the contents, the quality, the features and the learning methods of the course, the development history and basic knowledge of robot.

Chapter 2 Mathematical foundations

Because the robot is multidimensional space agencies, the basic mathematical knowledge including calculus is not enough to describe the displacement, velocity, acceleration, kinematics and dynamics of robot, this chapter teaches homogeneous transformation, rigid transformation, spinor theory.

Chapter 3 The robot structure

Tthis chapter describes the basics of robot mechanism, overview of the overall structure of institutions; describes the different drive programs and drives; according to the robot's job tasks, analysis of the mechanical structure of its requirements.

Chapter 4 The robot kinematics

The representations and solving methods of robot motion equations, Jacobian differential equation, robot kinematics equations.

Chapter 5 The robot Dynamics

The basic theories of robot dynamics, Lagrange mechanics, the robotics positive dynamics, the robot inverse dynamics.

Chapter 6 The robot Control

Discuss the basic principles of robot control, introduce and analyze robot position control, trajectory control, force control, torque control, compliance control, force/position hybrid control, resolved motion control, variable structure control, adaptive control, and hierarchical control.

Chapter 7 Robot Planning

Principle of Robot planning, the robot motion planning, robot path planning.

Chapter 8 The robot simulation and programming

Robot simulation technology, robot programming language, online and offline robot programming.

Chapter 9 Sensor technology

Discuss distance, force, torque, tactile, visual sensors.

Other Teaching links:

Experimental arrangements are (8 class hours):

① robot design, simulation and programming experiment (2);

② robot environmental perception experiments (2);

③ robot control experiments (4);

Testing

Final score: Homework-20pts; Experiment-20pts; Final exam-60pts.

No.	Experimental projects	Class hours	Requirements	Numbers
1	The robot design and programming	2	compulsory	4
2	Robot environment perception experiment	2	compulsory	4
3	Robot control experiment	4	compulsory	4

- 教案 **Teaching Plan**
- 视频 **Vide**