

Five Days Course on

Humanoid Robotics: Modelling and Control

For Practicing Engineers and Research Beginners

6th to 11th December 2017



Discipline of Mechanical Engineering
Indian Institute of Technology Indore
Indore, Madhya Pradesh, India
<http://iiti.ac.in/GIAN/>
<http://people.iiti.ac.in/~santhakumar/>

Course Contents

Introduction to Humanoid Robots
History and Applications
Static Walking
Modelling of a Biped Gait
Parameterization for Bipedal Robot
Rigid Contact and Reaction Forces
Dynamic Model of Humanoid Robots
Control via Linear Inverted Pendulum Model
Model Predictive Control
Capture Point and Falling Avoidance
Passive Walking and its Stability
Virtual Constraints
Concept of Hybrid Zero Dynamics
Under-actuation and Planar Walking
Case Studies

Examination and Certificate

An examination will be conducted at the end of the course and grade sheets as well as participation certificate will be give to all the participants.

Important Dates

Last date for Registration : November 15, 2017

Course schedule : December 6-11, 2017

Course Overview

Humanoid robots become more and more popular and can take a place in many area of the society, at home for healthy or disable people or in industry, service and for game or communication. While the study of humanoid robots can concern many topics, the course will be concentrated on the bipedal locomotion. The biped robot control is really challenging and highly different from other kinds of robots such as industrial robots and wheeled robots. Many difficulties occur due to the unilateral intermittent contact between the robot feet and the ground. The limited size of the feet induces limitation and the stability of the walking is not easy to obtain. This lecture course covers the most useful concepts for the modelling and control of walking of bipedal robots.

Course Objectives

The lecture course addresses students of undergraduate and graduate level (MTech, PhD students) as well as faculty teaching mechanical system topics who want to get more familiar with the modelling and control of bipedal robot.

The objectives of the course are:

- The students are aware of the difficulties of studying the walking of humanoid robots.
- The students have a deep understanding of the notion of stability of walking.
- The students know how to model a humanoid robot as a dynamic system taking into account the constraints and limits induced by the contact with the ground .
- The students are able to describe a gait of the robot with different phases as double support or single support.
- The students are able to derive the constraint equations describing the contact with the environment.
- The students are able to identify and interpret the notion of under-actuation and over-actuation that appears in the modelling of robot.
- The students are able to understand complete dynamic model and also simplified dynamic model and their influence in the design of control laws.

Teaching Faculty



Christine Chevallereau: After completing her master degree in Robotics at Ecole Nationale Supérieure de Mécanique de Nantes in 1985, she joined PhD and completed at the Ecole Centrale de Nantes - University of Nantes in 1989. Christine Chevallereau worked as a full-time researcher at the Centre National de la Recherche Scientifique (CNRS) since 1989 and took the position of a Director of Researcher in 2006. From 1987 to 1989, she worked as an Assistant Professor at Institut Universitaire de Technologie in Nantes. Currently, she is the Deputy Director of the Laboratory of Digital Sciences of Nantes.

Her Current Research interest includes:

- Modelling and control of robotic systems
- Humanoid robots and locomotor robots
- Optimal motion for walking and running of biped robot
- Computational morphology: Choice of design characteristics or gaits to achieve control properties
- Perception with electric sense

She has published 4 books, 37 publications in international journals, 12 books chapters and more than 100 communications in international conferences. She has supervised 14 PhD students and 41 Master students.



- Modelling of the human motion and muscle
- Control of humanoid robots (Locomotion, Manipulation and Interaction, Navigation)
- The human-humanoid interaction (Imitation, Cooperation, Motion Assistance) device

Course Coordinator



Santhakumar Mohan graduated in Mechanical Engineering from Government College of Engineering, Salem, Tamil Nadu (India) in 2003. He received his Master degree (ME) in the discipline of Manufacturing Engineering from Government College of Technology, Coimbatore, Tamil Nadu (India) in 2005. He got his PhD (Robotics and Control) from Indian Institute of Technology Madras, Chennai (India) in 2010. From June 2010 to March 2011, he worked as an assistant professor in the Department of Mechanical Engineering at National Institute of Technology Calicut (NITC), Kerala (India). He then worked as world-class university (WCU) postdoctoral fellow at Korean Advanced Institute of Science and Technology (KAIST), Daejeon (Republic of Korea), in addition to this, he received another prestigious Brain Korea 21 (BK21) Post-doctoral fellowship with the same institute from September 2011 to March 2012. In 2012, he joined the faculty of the Mechanical Engineering at Indian Institute of Technology Indore. Currently, he is the head, Centre for Robotics and Control, IIT Indore. He is holding visiting faculty positions at IISc Bangalore, India, RWTH Aachen, Germany and ECN, France. His active research areas include underwater vehicle control, underwater manipulator design and control, parallel robotic platforms, and dynamic modelling and control of dynamic systems. Recently, he has received the outstanding young Scientist for the year 2014 from Korea Robotics Society and Alexander von Humboldt Fellowship (2016–2017). He has published more than 100 articles in various journals and conference proceedings. He has 2 Indian patents in parallel robots and lower limb rehabilitation mechanisms.

Who can attend?

- Undergraduates, MTech/M.Sc, and PhD science stream students. Any student with a background in robotics (control and mechanical modelling) science will be able to follow these lectures and gain valuable information.
- BTech/B.Sc and MTech/M.Sc level teachers who wish to update their knowledge in an important special field of robot kinematics and design.
- Executives, engineers and researchers from industry, service and government organizations including R&D laboratories who are engaged in humanoid robotics.

Registration Fee

| | |
|----------------------------|--------------|
| Students (UG & PG) | : Rs. 3,000 |
| Research Scholars | : Rs. 4,000 |
| Faculty members | : Rs. 5,000 |
| Industry and others | : Rs. 10,000 |
| Foreigners (any positions) | : USD 250 |

Travel Information

Indore located in Central part of India in Madhya Pradesh State. It will well-connected by rail, road and air. The nearest railway station is Indore Junction and the nearest Airport is Devi Ahilyabai Holkar Airport. For queries regarding travel information, please contact the course coordinator.

Accommodation

Paid accommodation will be provided to participants on first-come-first-serve basis.

Course fee includes course material, tutorial sheets, lecture handouts, lunch and tea during course days

Contact Details

For any information regarding eligibility, fee payment, travel information, accommodation, etc., please contact the course coordinator via email or phone.

Dr. Santhakumar Mohan

Associate Professor

Discipline of Mechanical Engineering

Indian Institute of Technology Indore

#1A-210/1B-301, POD Building, Simrol Campus

Indore, Madhya Pradesh, INDIA - 453552

Email: santhakumar@iiti.ac.in

Phone: +91-7324306517

Link for registration: <http://gian.iiti.ac.in/register.php>

Please email the application form along with the proof of the registration fee payment to the course coordinator.

Fee payment details can be found at: <http://gian.iiti.ac.in/>