MODELING OF AERIAL AND PARALLEL ROBOTIC MANIPULATORS USING LIE GROUP AND SCREW THEORY

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Overview

Parallel kinematic manipulators (PKM) have become established as an alternative to classical serial manipulators. The advantages of PKM, compared to serial manipulators, are owed to a more complex kinematics and dynamics. Thus, the modeling and model-based control, as well design, are challenging tasks that demand advanced modeling approaches. In the last decades geometric Lie-group and screw theory has been successfully applied to the kinematics and dynamics of serial manipulators leading to compact user-friendly and computationally efficient formulations and algorithms. Such formulations were only recently proposed for PKM. This course gives a comprehensive introduction to modern geometric formulations and algorithms for the modeling and control of general PKM. It covers the theoretical as well as application oriented aspects.

Course participants will learn these topics through lectures and hands-on experiments. Also case studies and assignments will be shared to stimulate research motivation of participants.

Course Objectives

The course is intended for undergraduate and graduate students (B. Tech, M. Tech, PhD students) as well for faculty pursuing research on mechanical systems or control who want to learn about modern approaches to the kinematics and dynamics modeling of control of PKM.

The objectives of this course can be summarized as follows:

- The participants have a thorough knowledge of the phenomenology of PKM;
- The participants are familiar with different actuation schemes of PKM;

- The participants know how to represent the topology of general mechanisms and how to account for the specifics of PKM;
- The participants are able to model the kinematics of PKM using concepts from screw and Lie group theory;

Modules and schedules	**A:<u>Day 1: 24-02-2025</u>** Inauguration Lecture 1 (1h): Introduction, Representation of mechanism topology Lecture 2 (1h: Rigid body motions Tutorial 1: Kinematics of planar 3DOF PKM (AM) **B: <u>Day 2: 25-02-2025</u>** Lecture 3 (1h): Finite kinematics of serial chains using screws and Lie groups Lecture 4 (1h): Instantaneous kinematics of serial chains using screws and Lie groups Tutorial 2: Kinematics of spatial 3DOF and 6DOF PKM **C: <u>Day 3: 26-02-2024</u>** Lecture 5 (1h): Second-order kinematics of serial chains using screws and Lie groups Lecture 6 (1h): Kinematics of PKM Lecture 7 (1h): Dynamics of serial kinematic chains **D: <u>Day 4: 27-02-2025</u>** Lecture 8 (1h): Dynamics of PKM Lecture 9 (1h): Model-based control of PKM Lecture 10 (1h): Kinematics of planar PKM **E: <u>Day 5: 28-02-2025</u>** Lecture 11 (1h): Redundantly actuated PKM Lecture 12 (1h): Dynamics of Planar PKM **Evaluation of Learning Outcomes (Examination/Test, Feedback) & Certificate distribution.** **<u>Number of participants for the course will be limited to fifty.</u>**
Who can attend …	•Anyone with a degree in Mechanical, Aerospace/Aeronautical, Civil, Chemical, Energy or relevant branches of Engineering and Science. •Student at all levels (B.Tech./B.Eng./B.Sc./M.Sc./MTech./Ph.D.) and faculty members/academic staff from universities and institutions. •Engineers, Scientists and Professionals working in companies, industries and R&D institutions
Fees	The participation fees for taking the course is as follows: a. Participants from abroad: USD 250

	b. Participants from Industry/Research Organizations: Rs. 5000/- c. Participants from Academic Institutions: i. Faculty member: Rs. 2000/- ii. External Students: Rs. 500/- iii. Internal PG & PhD Students: Rs. 500/- iv. Internal UG Students: Nil The above fee include all instructional materials, computer use for tutorials and assignments, laboratory equipment usage charges, 24 hr free internet facility. The participants may be provided with accommodation on payment basis.

The Faculty (Experts)

Andreas Müller (a.muller@jku.at) received the Diploma degree in mathematics from the University of Applied Sciences, Mittweida, Germany, in 1997 and the Diploma degree in Mechanical Engineering, and the Ph.D. degree in mechanics (with honors) from the University of Technology, Chemnitz, Germany in 2001 and 2004, respectively. He received the Habilitation in mechanics from University Duisburg-Essen, Germany, in 2008. He is currently a full professor in robotics at the Johannes Kepler University, Linz, Austria. His current research interests include holistic modeling, model-based and optimal control of mechatronic systems, mechanism theory, geometric mechanics, redundant robotic systems, parallel kinematic machines, biomechanics, and computational dynamics. He served as an associate editor of various journals, including IEEE Transactions on Robotics, IEEE Robotics and Automation Letters, ASME Journal of Mechanisms and Robotics, Mechanism Machine Theory, and Meccanica.

Yogesh Singh graduated in Mechanical Engineering from Government College of Engineering, Jagdalpur, Chhattisgarh (India) in 2008. He received M. Tech degree in Machine Design from National Institute of Technology Rourkela, Odisha, India, in 2012. He got his PhD (Robotics) from Indian Institute of Technology Indore, MP (India) in 2016. He then worked as postdoctoral fellow at Indian Institute of Technology Bombay, India, from January 2017 to July 2017. From August 2017 to July 2018, he worked as an assistant professor in the Department of Mechanical Engineering at SRM Institute of Science and Technology Chennai, India. . In July 2018, he joined the faculty of the Mechanical Engineering at National Institute of Technology Silchar, Assam, India. His main research interests include kinematic and dynamic modelling of the robotic manipulator, parallel manipulator and nonlinear control of robotic systems. He has published more than 40 articles in top class journals and conference proceedings. He has four externally funded research projects from DST, CSIR and SERB, Govt. of India.

Course Co-ordinator

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About Silchar

Silchar is the second largest town in the state of Assam. It was the kingdom of the Kachchari kings from 1755 to 1830. It was annexed to the British East India Company in 1833. The city has now attained a cosmopolitan status with inhabitants from all over India although Bengali speaking people constitute the majority. It is an educational and business hub in North East India next to Guwahati. Aesthetically the campus is very beautiful with greeneries and wet lands. During the month of July-August the weather in Silchar is quite humid. During this period, the average high is 35°C and the average low is 25°C.

How to reach NIT Silchar

The city is well connected by Road, Train and Air. There are direct flights from Kolkata and Guwahati and trains from New Delhi, Kolkata, Guwahati, and Agartala. Daily bus services are available from Agartala, Guwahati, Aizawl, and Imphal. The Institute is located around 35 kms from the Silchar airport, 10 kms from the Silchar railway station, 14 kms from ISBT Silchar, and 8 kms from the heart of the Silchar town. Prepaid taxi and auto services are available from Silchar.

Registration Guidelines (Step-by-Step):

1. Courses Registration for GIAN course may be done by paying the requisite fees as below through SBI collect.
   SBI Collect Name: GIAN COURSE NIT SILCHAR, 2412209, Yogesh Singh
   a. Participants from abroad: USD 250
   b. Participants from Industry/Research Organizations: Rs. 5000/-
   c. Participants from Academic Institutions:
   i. Faculty member: Rs. 2000/-
   ii. External Students: Rs. 500/-
   iii. Internal PG & PhD Students: Rs. 500/-
   iv. Internal UG Students: Nil
2. Fill out the Registration form given below, sign it. Send the scan copy of the filled in form with scanned copy of course fee transaction slip obtained by SBI collect to the course coordinator e-mail address (**yogeshsingh15@gmail.com or yogesh@mech.nits.ac.in**). This is for the Course Coordinator's record. Now, await the Course Coordinator's confirmation.

GIAN: Global Initiative of Academic Network

NAME OF THE COURSE: MODELING OF AERIAL AND PARALLEL ROBOTIC MANIPULATORS USING LIE GROUP AND SCREW THEORY

(Course ID: 2412209)

Dates: 24-28 February, 2025

Department of Mechanical Engineering, NIT Silchar, Assam, India

REGISTRATION FORM

GIAN Portal Application Number (if any):

Full Name: Category (Industry/Academic/Student):

Organization:

Address:

Email Id:

Mobile Number:

Highest Academic qualification:

SBI Collect payment details:

Transaction Id/Ref No	Date	Amount

Accommodation Required: Yes/No (please tick in the applicable field)

Date:

Place:

Signature of Applicant