22AIE214 INTRODUCTION TO AI ROBOTICS L-T-P-C: 2- 0- 3- 3

Course Objectives

- To provide an introductory understanding of robots and its components.
- To introduce different paradigms used in AI robotics.
- To introduce the mathematical concepts needed for understanding basic robotic system operation.
- To introduce kinematics and its application in robotic manipulators.

Course Outcomes

After completing this course student will be able to,

CO1: Analyse a robotic system using different paradigms of AI robotics.

CO2: Apply mathematical concepts to represent the position and orientation of robotic systems.

CO3: Perform the forward and inverse kinematics of canonical robotic systems.

CO4: Simulate robotic systems using state-of-the-art computational platforms.

CO-PO Mapping

PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO															
CO 1	3	1	3	2	1	2	2	2	3	3	3	3	3	2	3
CO 2	3	3	2	2	3	-	-	-	3	3	-	3	3	1	3
CO 3	3	3	2	2	3	-	-	-	3	3	-	3	3	1	3
CO 4	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3

Syllabus

Unit 1

Introduction to robots – Brief History – Types of robots – Teleoperation.

Unit 2

Attributes of the hierarchal paradigm - Attributes of the reactive paradigm – Biological foundations of the reactive paradigm – Common sensing techniques for reactive robots – Attributes of hybrid paradigm.

Unit 3

Mathematical representation of robots – Position and orientation of rigid bodies – Rotation and Orientation – Quaternions and other rotation representations - Transformation Matrix

Unit 4

D-H parameters – Forward and inverse kinematics of robot manipulators.

Lecture Plan

Lecture Hours	Topics	Key-words	Course Outcomes	Resource
Week 1	Introduction to Robots	Course overview, Definition, History, Current Trends, AI in Robotics, Characteristics and features of robots, Degree of freedom	CO1	Introduction to Robotics Matlab Installation document
Week2	MATLAB Robotics Toolbox Introduction	Laws of Robotics-History-Types of Robots- Getting started with Robotics toolbox, Models of Robots in Matlab(demonstration)	CO1	Laws of Robotics-History-Types of Robots Applications of Robotics
Week3	Paradigms	Attributes of the hierarchal paradigm - Attributes of the reactive paradigm – Biological foundations of the reactive paradigm – Common sensing techniques for reactive robots – Attributes of hybrid paradigm.	CO1	Attributes of the hierarchal paradigm - Attributes of the reactive paradigm – Biological foundations of the reactive paradigm – Common sensing techniques for reactive robots – Attributes of hybrid paradigm.
Week4	Mathematical Representation of Robots	Representing position and orientation in 2D surface, Representing position and orientation in 3D environment, Representation of 3D pose in Homogeneous transformation matrix	CO2	Point and Object in 2D space-POSE-Relative POSE-Homogeneous Transform-Multiple Frames
Week5	Point and Object in 2D Space	Implementing and visualizing	CO2	

		transformation and rotations in 2D		
Week 6	Point and Object in 2D Space	Implementing and visualizing transformation and rotations in 3D Lab work - 2D and 3D space translation and orientation	CO2	Point and Object in 3D space
Week 7	Orientation in 3 Dimensions	Three angle representation - Euler angles, Cardanian angles Two vector representation	CO2	
Week 8	Representing position and orientation	Rotation about an arbitrary vector Matrix exponentials Quaterions Twists	CO2	Representing position and orientation
Week 9	Orientation in 3 Dimensions	DH parameters Case Study with SCARA robot Robo analyzer Demonstration	CO2	Refer class notes for DH parameters and computational problems http://www.roboanalyzer.com/
Week 9	Robotic Manipulators	Manipulator anatomy, Degree of Freedom (DoF) and	CO2	Degree of freedom

		configuration, work space		Case Study on Robotic manipulator - Research paper Types of robot based on configuration
Week 10	Introduction to Kinematics	Forward kinematics and Inverse kinematics, DH parameter, Design problems in kinematics and MATLAB implementation	CO3	Forward Kinematics and Inverse Kinematics Refer class notes for computational problems
Week 10	Trajectory Planning	Jacobian, Singularities, force and torque and MATLAB implementation	CO3	Jacobian and Singularities
Week 11	Mobile Robotics	Wheeled mobile robots, Reactive navigation, map based navigation Techniques for 3D mapping	CO4	Wheeled mobile robot Mobile robot navigation Techniques for 3D mapping
Week 12	Mobile Robotics	Localization and MATLAB implementation Robot navigation - Lab work	CO4	Robot navigation - Lab work
Week 13	Case Study	Presentations	CO4	
Week 14	Case Study	Presentations	CO4	

Text Book /Reference Books:

'Robotics, Vision & Control', P. Corke, 2nd edition, Springer, 2011

'Robot Modeling and Control', M.W. Spong, S. Hutchinson and M. Vidyasagar, Wiley, 2006

'Robotics: Fundamental Concepts & Analysis', A. Ghosal, Oxford University Press, Ninth Edition, 2006

'Introduction to Robotics', T. Bajd, M. Mihelj and M. Munih, Springer Briefs in Applied Sciences and Technology, 2013

'Introduction to AI Robotics', Robin Murphy, MIT Press, 2000

Evaluation Pattern

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Assessment	Internal/External	Weightage (%)
Assignments (2 nos)	Internal	30
Quizzes (2 nos)	Internal	20
Mid-Term Examination	Internal	20
End Semester Examination	External	30

Assessment		**Weightage(%)**
Assignment (2 nos.) **Submission after 4^{th} Lab and 9^{th} Lab Days**		**2*15 = 30**
Assignment 1(15 marks) **(Based on Lab exercises 1-4)** **Submission after 5^{th} Lab Day** **On time submission and report style – 2 marks** **Lab evaluations during lab hours – Total 3 marks** **(Lab evaluation on 2^{nd}, 5^{th} Lab days)** **Lab Viva (On 6^{th} Lab day) – 10 marks**	**Assignment 2(15 marks)** **(Based on Lab exercises 5-7)** **Submission after 10^{th} Lab Day** **On time submission and report style – 2 marks** **Lab evaluations during lab hours – Total 3 marks** **(Lab evaluation on 11^{th}, 12^{th} Lab days)** **Case Study presentation – 7 marks** **Case Study report – 3 marks**	
Quiz (2 nos.)		**2*10 = 20**

Quiz 1 **After 4th week** **30 minutes test**	**Quiz 2** **After 9th week** **30 minutes test**	
Mid Term Exam (50 marks) **2 hours written exam**		**20**
End Sem Exam (100 marks) **3 hours written exam**		**30**

Course Faculty

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