Course Code	Corse Title	L	T	P	C
BCSE427L	Cognitive Robotics	2	0	0	2
Pre-requisite	NIL	Syllabus Version 1.0			

Course Objectives:

1. To understand the main types of cognitive (vision, motor control, language, social skills) robots and their driving requirements (engineering operations, navigation, cooperation)
2. To understand advanced methods for creating efficient and dynamic cognitive robots.
3. To understand the recent literature, and collectively synthesize, clearly explain and evaluate the state of the art in cognitive robotics.
4. To apply one or more core reasoning methods to create a simple agent that is driven by goals or rewards.

Course Outcomes:

After the completion of the course, student will be able to:

1. Understand how our psychology and neuroscience understanding of behavior and intelligence informs the design of robotics models and applications
2. Compare, select and apply different machine learning methods for intelligent behavior in robots.
3. Analyze the methods and software/hardware technologies for robotics research and applications.
4. Discuss the state of the art in cognitive and intelligent robotics models, and how this leads to the design of future robot applications.

Module:1	Introduction	2 hours

Thinking, Cognition, and Intelligence, Defining Intelligence – Embodiment and Its Implications, Synthetic Methodology for Intelligence.

Module:2	Cybernetic View of Robot Cognition and Perception	4 hours

Introduction to the Model of Cognition, Visual Perception, Visual Recognition, Machine Learning, and Robot Cognition.

Module:3	Intelligent System Design, Cognition Development and control	5 hours

Properties of Complete Agents, Agent Design Principle, Developmental Robot Design, Matching brain and Body Dynamics, Artificial Neural Networks (ANN), Fuzzy Logic, Genetic Algorithms and Other Nature Inspired Methods, Optimal Control using ANN, Introduction to CNN.

Module:4	Map Building	5 hours

Introduction, Constructing a 2D World Map, Data Structure for Map Building, Explanation of the Algorithm, An Illustration of Procedure Map Building.

Module:5	Randomized Path Planning	5 hours

Introduction, Representation of the Robot's Environment, Review of configuration spaces, Visibility Graphs, Voronoi diagrams, Potential Fields and Cell Decomposition, Planning with moving obstacles, Probabilistic Roadmaps, Rapidly exploring random trees, Execution of the Quad tree-Based Path Planner Program.

Module:6	Simultaneous Localization and Mapping (SLAM)	5 hours

Problem Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended Kalman filter, Graph-Based Optimization Techniques, Particle Methods Relation of Paradigms.

Module:7	Robot Programming methods	3 hours

Python Robot Programming Methods-: Go-to-Goal Behavior, Avoid-Obstacles Behavior, Hybrid Automata (Behavior State Machine), Follow-Wall Behavior. A Complete Program for autonomous mobile robot.		
Module:8	**Contemporary issues**	**1 hours**
	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Patnaik, Srikanta, "Robot Cognition and Navigation – An Experiment with Mobile Robots", Springer Verlag Berlin and Heidelberg, 2007	
2.	Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.	
3	David Vernon, "Artificial Cognitive Systems: A Primer" ,The MIT Press, 1st Edition,2014	
Reference Book(s)		
1.	HoomanSomani, "Cognitive Robotics", CRC Press, 2015	
2.	Jared Kroff, "Cognitive Robotics: Intelligent Robotic Systems", Wilford Press, 2016	
3.	https://www.toptal.com/robotics/programming-a-robot-an-introductory-tutorial	

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BCSE427P	**Cognitive Robotics Lab**	**0**	**0**	**2**	**1**
Pre-requisite	**NIL**	**Syllabus Version**			
		1.0			

Course Objectives:

1. To understand advanced methods for creating efficient and dynamic cognitive robots
2. To apply one or more core reasoning methods to create a simple agent that is driven by goals or rewards

Course Outcomes:

After the completion of the course, student will be able to:

1. Understand how our psychology and neuroscience understanding of behavior and intelligence informs the design of robotics models and applications
2. Compare, select and apply different machine learning methods for intelligent behavior in robots.
3. Apply the methods and software/hardware technologies for robotics research and applications.
4. Implement the state of the art in cognitive and intelligent robotics models, and how this leads to the design of future robot applications.

List of Challenging Experiments (Indicative)

1	Introduction to the Python language and Python libraries, including NumPy, SciPy and NXT Python • Introduction to numerical arrays and parallel arithmetic • Introduction to numerical data plotting • • Introduction to numerical regression techniques • Installing Raspbian OS on the Raspberry Pi 3	4 hours
2	Introduction to microcontrollers (32-bit ARM-based devices) in embedded applications used in automobiles and home appliances (such as washing machines, microwave ovens, telephones, and computer system peripherals) • Controlling GPIO pins (e.g., connected to LEDs) on the Raspberry Pi 3 using Python • Controlling motors • Collecting sensor data (such as light-color sensor, touch sensor, infrared proximity sensor and ultrasonic sensor) • Writing and uploading robotic control programs	4 hours
3	Interfacing data acquisition system hardware with computer to measure and control the robotic system.	4 hours
4	Robotic motion and autonomous responses • Path following, solving a Rubix cube, book scanning, and other fun problems	4 hours
5	Machine learning algorithms for neural network pattern recognition	4 hours
6	Extend the deep learning exercises (e.g. Multi-Layer Perceptron (MLP) and/or Convolutional Neural Network (CNN) exercises for image datasets) to optimize the training for robotics (vision) applications.	6 hours
7	SLAM in ROS	4 hours
	Total Laboratory Hours	**30 hours**

Text Book(s)

1.	Learning Computing with Robots, Deepak Kumar, Institute for Personal Robots in Educaition, June 2008

Reference Books

1.	Programming Cognitive Robots, Hector J. Levesque, 2019
2.	Learning Robotics Using Python, Lentin Joseph, 2015
3.	https://www.ieee-ras.org/cognitive-robotics/resources (Research Challenges)

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).			
Recommended by Board of Studies	13-05-2022		
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