Training Course on Advanced Robotics and AI Integration

Professional Development Training Course Outline

Category	Engineering	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Introduction

This comprehensive training course on Advanced Robotics and AI Integration offers a deep dive into the synergistic fusion of cutting-edge robotic systems with intelligent artificial intelligence capabilities. Participants will gain expert-level understanding of advanced robotic kinematics, dynamics, control strategies, and perception systems, alongside the foundational and applied principles of Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) that enable robots to learn, adapt, and make autonomous decisions. Training Course on Advanced Robotics and AI Integration meticulously covers topics ranging from robot operating systems (ROS), robotic manipulation, mobile robotics, and human-robot interaction (HRI), to computer vision, reinforcement learning, natural language processing (NLP) for robots, and cognitive robotics. Attendees will acquire hands-on experience with industry-standard simulation tools (e.g., Gazebo, CoppeliaSim), programming frameworks (e.g., Python, TensorFlow, PyTorch), and real robotic platforms, essential for shaping the future of intelligent automation across diverse industries.

The program emphasizes practical implementation and addresses trending topics in robotics and AI, including collaborative robots (cobots), autonomous navigation in complex environments, explainable AI (XAI) for robotic decision-making, digital twins for robot simulation and control, tactile sensing and manipulation, and ethical considerations in AI-driven robotics. Participants will delve into the intricacies of real-time data processing, sensor fusion, robust control under uncertainty, and the challenges of deploying AI models on embedded robotic hardware. By the end of this course, attendees will possess the expertise to design, program, and deploy sophisticated robotic systems that leverage AI for enhanced autonomy, adaptability, and performance, enabling them to lead innovation and overcome complex engineering challenges in manufacturing, logistics, healthcare, defense, and exploration. This training is indispensable for professionals driving the next generation of intelligent robotic solutions.

Programme Curriculum

Training Course on Advanced Robotics and AI Integration

Introduction

This comprehensive training course on Advanced Robotics and AI Integration offers a deep dive into the synergistic fusion of cutting-edge robotic systems with intelligent artificial intelligence capabilities. Participants will gain expert-level understanding of advanced robotic kinematics, dynamics, control strategies, and perception systems, alongside the foundational and applied principles of Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) that enable robots to learn, adapt, and make autonomous decisions. Training Course on Advanced Robotics and AI Integration meticulously covers topics ranging from robot operating systems (ROS), robotic manipulation, mobile robotics, and human-robot interaction (HRI), to computer vision, reinforcement learning, natural language processing (NLP) for robots, and cognitive robotics. Attendees will acquire hands-on experience with industry-standard simulation tools (e.g., Gazebo, CoppeliaSim), programming frameworks (e.g., Python, TensorFlow, PyTorch), and real robotic platforms, essential for shaping the future of intelligent automation across diverse industries.

The program emphasizes practical implementation and addresses trending topics in robotics and AI, including collaborative robots (cobots), autonomous navigation in complex environments, explainable AI (XAI) for robotic decision-making, digital twins for robot simulation and control, tactile sensing and manipulation, and ethical considerations in AI-driven robotics. Participants will delve into the intricacies of real-time data processing, sensor fusion, robust control under uncertainty, and the challenges of deploying AI models on embedded robotic hardware. By the end of this course, attendees will possess the expertise to design, program, and deploy sophisticated robotic systems that leverage AI for enhanced autonomy, adaptability, and performance, enabling them to lead innovation and overcome complex engineering challenges in manufacturing, logistics, healthcare, defense, and exploration. This training is indispensable for professionals driving the next generation of intelligent robotic solutions.

Course duration

10 Days

Course Objectives

1. Understand the fundamental principles of advanced robotics, including kinematics, dynamics, and control.
2. Master Robot Operating System (ROS) for robot development, simulation, and deployment.
3. Implement advanced perception techniques using computer vision and sensor fusion for robotic applications.
4. Apply Machine Learning and Deep Learning algorithms for object recognition, scene understanding, and decision-making.
5. Design and program autonomous navigation strategies for mobile robots in complex environments.
6. Develop robot manipulation skills for tasks involving grasping, assembly, and interaction.
7. Comprehend the principles of human-robot interaction (HRI) for intuitive and safe collaboration.
8. Utilize Reinforcement Learning (RL) for teaching robots complex behaviors and optimizing policies.
9. Integrate Natural Language Processing (NLP) for voice control and natural communication with robots.

10. Explore cognitive robotics and AI planning algorithms for high-level reasoning.
11. Address real-time computing, embedded AI, and hardware acceleration for robotic platforms.
12. Design for robustness, fault tolerance, and safety in AI-integrated robotic systems.
13. Understand ethical considerations and societal impact of advanced robotics and AI.

Organizational Benefits

1. Accelerated development and deployment of intelligent robotic solutions.
2. Enhanced automation capabilities in manufacturing, logistics, and service industries.
3. Improved efficiency, precision, and adaptability of robotic systems.
4. Reduced operational costs through increased autonomy and optimized task execution.
5. Competitive advantage in adopting cutting-edge robotics and AI technologies.
6. Development of in-house expertise in a rapidly growing and high-demand technological domain.
7. Faster iteration and prototyping of complex robotic applications.
8. Increased safety and collaboration in human-robot co-working environments.
9. Exploration of new revenue streams through advanced robotic services and products.
10. Contribution to digital transformation initiatives and Industry 4.0 adoption.

Target Participants

- Robotics Engineers
- AI/Machine Learning Engineers
- Automation Engineers
- Software Developers (Robotics, AI)
- Control Systems Engineers
- Mechatronics Engineers
- Researchers in Robotics and AI
- Product Development Managers in Automation and Tech

Course Outline

Module 1: Foundations of Robotics

- **Robot Kinematics:** Forward and inverse kinematics for manipulators.
- **Robot Dynamics:** Lagrangian and Newton-Euler formulations.
- **Robot Control Systems:** Joint space and task space control, PID control.
- **Robot Types and Applications:** Industrial, mobile, service, collaborative robots.
- **Case Study:** Deriving the forward kinematics for a 6-DOF industrial robotic arm.

Module 2: Robot Operating System (ROS) for Development

- **ROS Architecture:** Nodes, topics, services, messages, parameters.
- **ROS Tools:** Rviz, Gazebo, rosbag for simulation and debugging.
- **ROS Programming:** Python and C++ for ROS nodes.
- **ROS Packages and Workspaces:** Building and managing projects.
- **Case Study:** Building a simple ROS package to control a simulated mobile robot's movement in Gazebo.

Module 3: Robotic Perception with Computer Vision

- **Camera Models:** Pinhole, calibration, distortion.
- **Image Processing Fundamentals:** Filtering, edge detection, feature extraction.
- **Object Detection and Recognition:** Traditional vs. Deep Learning methods (YOLO, Faster R-CNN).
- **3D Vision:** Stereo vision, RGB-D cameras (Kinect, RealSense).
- **Case Study:** Implementing a real-time object detection pipeline using a webcam and a pre-trained Deep Learning model in ROS.

Module 4: Advanced Sensing and Sensor Fusion

- **LiDAR (Light Detection and Ranging):** 2D/3D LiDAR for mapping and localization.
- **Radar:** Principles, applications for robust perception in adverse conditions.
- **IMU (Inertial Measurement Unit) and GNSS:** Localization and pose estimation.
- **Sensor Fusion Algorithms:** Kalman Filters, Extended Kalman Filters, Particle Filters for robust state estimation.
- **Case Study:** Fusing LiDAR and IMU data using a Kalman Filter to improve the pose estimation of a mobile robot.

Module 5: Fundamentals of Artificial Intelligence and Machine Learning

- **AI vs. ML vs. DL:** Definitions and relationships.
- **Supervised Learning:** Classification, regression.
- **Unsupervised Learning:** Clustering, dimensionality reduction.
- **Reinforcement Learning (RL) Basics:** Agents, environments, rewards, policies.
- **Case Study:** Training a simple supervised learning model to classify objects based on sensor features.

Module 6: Deep Learning for Robotics

- **Neural Networks:** Architectures (CNNs, RNNs, LSTMs).
- **Deep Learning Frameworks:** TensorFlow, PyTorch.
- **End-to-End Learning:** Direct mapping from sensor input to control actions.
- **Transfer Learning and Data Augmentation:** Improving model performance with limited data.
- **Case Study:** Implementing a Convolutional Neural Network (CNN) for semantic segmentation of a robot's environment from camera images.

Module 7: Autonomous Navigation for Mobile Robots

- **Localization:** Monte Carlo Localization (MCL), Kalman-based localization.
- **Mapping:** Occupancy grids, SLAM (Simultaneous Localization and Mapping).
- **Path Planning:** A*, Dijkstra, RRT (Rapidly-exploring Random Tree).
- **Motion Control:** PID, pure pursuit, robust path following.
- **Case Study:** Implementing a full SLAM and navigation stack for a simulated mobile robot in ROS.

Module 8: Robotic Manipulation and Grasping

- **End-Effector Design:** Grippers, suction cups.
- **Inverse Kinematics for Manipulation:** Reaching target poses.
- **Grasping Algorithms:** Analytical vs. Learning-based grasping.
- **Force Control and Compliance:** Interaction with objects.

- **Case Study:** Programming a robotic arm to perform a pick-and-place operation using visual servoing for object localization.

Module 9: Human-Robot Interaction (HRI)

- **Collaboration vs. Coexistence:** Safety standards (ISO 10218, ISO/TS 15066).
- **Intuitive Interfaces:** Gesture control, voice commands, augmented reality.
- **Safety in HRI:** Collision avoidance, proximity sensing.
- **Psychology of HRI:** Trust, acceptance, workload.
- **Case Study:** Designing an interactive task where a human and a collaborative robot safely share a workspace.

Module 10: Reinforcement Learning in Robotics

- **RL Algorithms:** Q-learning, Policy Gradients, DDPG, SAC.
- **Simulation for RL:** Training robots in virtual environments.
- **Reward Function Design:** Shaping behavior for complex tasks.
- **Sim-to-Real Transfer:** Bridging the gap between simulation and real-world deployment.
- **Case Study:** Training a robot to learn a simple locomotion or manipulation task using a Reinforcement Learning algorithm in a simulated environment.

Module 11: Cognitive Robotics and AI Planning

- **Knowledge Representation:** Ontologies, semantic maps.
- **AI Planning:** Classical planning (STRIPS), hierarchical task networks (HTN).
- **Reasoning and Decision Making:** Goal-oriented autonomy.
- **Learning from Demonstration (LfD):** Teaching by example.
- **Case Study:** Developing a high-level task planner for a service robot to fulfill complex requests from a user.

Module 12: Real-time Systems, Embedded AI, and Hardware

- **Real-time Operating Systems (RTOS) for Robotics:** VxWorks, Xenomai, ROS 2.
- **Embedded AI Hardware:** GPUs (NVIDIA Jetson), TPUs, FPGAs for edge inference.
- **Optimizing AI Models for Edge Deployment:** Quantization, pruning.
- **Sensors and Actuators Integration:** Interfacing with microcontrollers.
- **Case Study:** Deploying a pre-trained object detection model on an NVIDIA Jetson board to run on a mobile robot in real-time.

Module 13: Robustness, Fault Tolerance, and Safety in Robotics

- **Fault Detection and Isolation (FDI):** Identifying component failures.
- **Fault-Tolerant Control:** Maintaining operation despite faults.
- **Redundancy:** Sensor, actuator, and computational redundancy.
- **Robotic Safety Standards:** ISO 13849 (functional safety), ISO 10218.
- **Case Study:** Designing a redundant sensor system for an autonomous mobile robot to enhance safety during navigation.

Module 14: Digital Twins and Robot Simulation

- **Digital Twin Concept:** Virtual replica of a physical robot for monitoring and control.
- **Advanced Simulation Environments:** Gazebo, CoppeliaSim, Isaac Sim.
- **Simulation for Development and Testing:** Reducing physical prototyping.
- **Sim-to-Real Transfer:** Bridging the reality gap, domain randomization.

- **Case Study:** Creating a digital twin of a robotic cell in a simulation environment to test new control algorithms before deployment on the physical robot.

Module 15: Ethical Considerations and Future of Robotics and AI

- **Ethical AI:** Bias, fairness, accountability.
- **Job Displacement and Economic Impact:** Automation's societal effects.
- **Legal and Regulatory Frameworks:** Autonomous systems liability.
- **Robotics in Society:** Healthcare, defense, exploration, daily life.
- **Case Study:** Discussing the ethical implications of deploying autonomous robots in elder care or military applications.

Training Methodology

This course employs a participatory and hands-on approach to ensure practical learning, including:

- Interactive lectures and presentations.
- Group discussions and brainstorming sessions.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

Ready to enroll or request a customized program? Book online or contact us:

Register Online Now