Autonomous Systems

Self-Driving Cars

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Course Outline

Introduction

This course delves into the exciting realm of autonomous systems, focusing specifically on the development and application of self-driving car technology.

Participants will gain a comprehensive understanding of the fundamental concepts, algorithms, and technologies that drive these innovative vehicles.

From sensor fusion to deep learning, this course covers the essential aspects of self-driving cars and equips learners with the knowledge and practical skills needed to contribute to this evolving field.

Course Objectives

Understand the course's purpose, outcomes, and expected skills.

Course Objectives

Knowledge

Provide participants with a solid foundation in the fundamentals of autonomous systems, particularly as they apply to automotive engineering.

Skills

Teach essential algorithms and models used in self-driving cars, including perception, localization, control, and path planning.

Application

Equip participants with hands-on programming experience using deep learning, computer vision, and sensor fusion technologies.

Course Modules

Modules Breakdown

This course is divided into a series of modules, each covering a specific topic or skill.

Each module features interactive lessons, activities, and assessments to reinforce learning.

Modules are structured in a logical order, building upon previous knowledge and skills.

Module 1: Introduction to Autonomous Systems and Self-Driving Cars

- Overview of autonomous systems in various industries, with a focus on the automotive sector.
- Key components of self-driving cars: sensors, actuators, and decision-making algorithms.
- Introduction to ROS and its role in autonomous systems development.

Module 2: Automotive Engineering for Autonomous Vehicles

- Vehicle dynamics and control systems for autonomous cars.
- Key automotive components involved in autonomous driving: engine control, braking systems, and steering mechanisms.
- Real-time systems and embedded software for vehicle automation.

Module 3: Sensor Fusion and Perception in Autonomous Driving

- Overview of sensors used in autonomous vehicles: LiDAR, radar, cameras, and ultrasonic sensors.
- Techniques for fusing data from multiple sensors to create a coherent view of the environment.
- Introduction to Kalman filtering and its advanced variants for sensor fusion.

Module 4: Deep Learning for Computer Vision in Autonomous Cars

- Basics of deep learning and its applications in object detection, classification, and tracking.
- Implementing convolutional neural networks (CNNs) for vehicle and pedestrian detection.
- Lane detection, road segmentation, and scene understanding using computer vision techniques.

Module 5: Localization and Mapping

- Introduction to SLAM (Simultaneous Localization and Mapping) and its importance in autonomous navigation.
- GPS, inertial measurement units (IMUs), and wheel odometry for vehicle localization.
- Advanced techniques like particle filters and graph-based SLAM.

Module 6: Path Planning and Control

- Path planning algorithms: Dijkstra's, A*, and Rapidly-exploring Random Trees (RRT).
- Motion planning in dynamic environments and obstacle avoidance.
- Control systems for autonomous driving: PID control, Model Predictive Control (MPC).

Module 7: Safety, Ethics, and Regulations in Autonomous Driving

- Legal frameworks and regulations for autonomous vehicles.
- Ethical considerations: decision-making in life-critical situations, privacy, and data security.
- Safety standards and testing protocols for autonomous driving systems.

Module 8: Final Project and Industry Applications

- Real-world applications of autonomous systems in logistics, transportation, and smart cities.
- Final project: Designing and implementing a simple autonomous driving system using Python and ROS.
- Case studies on industry leaders like Tesla, Waymo, and Nvidia in the field of autonomous vehicles.

Learning Outcomes

Upon completion, students will gain valuable knowledge, skills, and abilities.

Learning Outcomes

Knowledge

Understand the core concepts and challenges in designing autonomous systems, particularly for self-driving cars.

Skills

Gain hands-on experience in developing and testing algorithms for perception, decision-making, and control.

Abilities

Be able to integrate various technologies, including deep learning, computer vision, and sensor fusion, into an autonomous driving system.

Target Audience

Who Should Take This Course?

This course is designed for individuals seeking to expand their knowledge and skills in a specific field.

It is suitable for professionals looking to enhance their expertise or individuals with a keen interest in the subject matter.

This course is ideal for:

- Engineers and computer scientists interested in pursuing careers in autonomous vehicle development.
- Automotive engineers who wish to deepen their knowledge of autonomous systems.
- Data scientists and AI enthusiasts eager to apply deep learning and computer vision to real-world problems.
- Graduate students or professionals in robotics and artificial intelligence looking to expand their expertise in self-driving technologies.

Conclusion

This Autonomous Systems and Self-Driving Cars course provides a comprehensive and engaging exploration of this rapidly developing field.

By combining theoretical knowledge with hands-on experience, participants will be well-equipped to pursue careers or research projects in autonomous vehicle development, contributing to the future of transportation.

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