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INSTITUTE OF
AERONAUTICAL ENGINEERING

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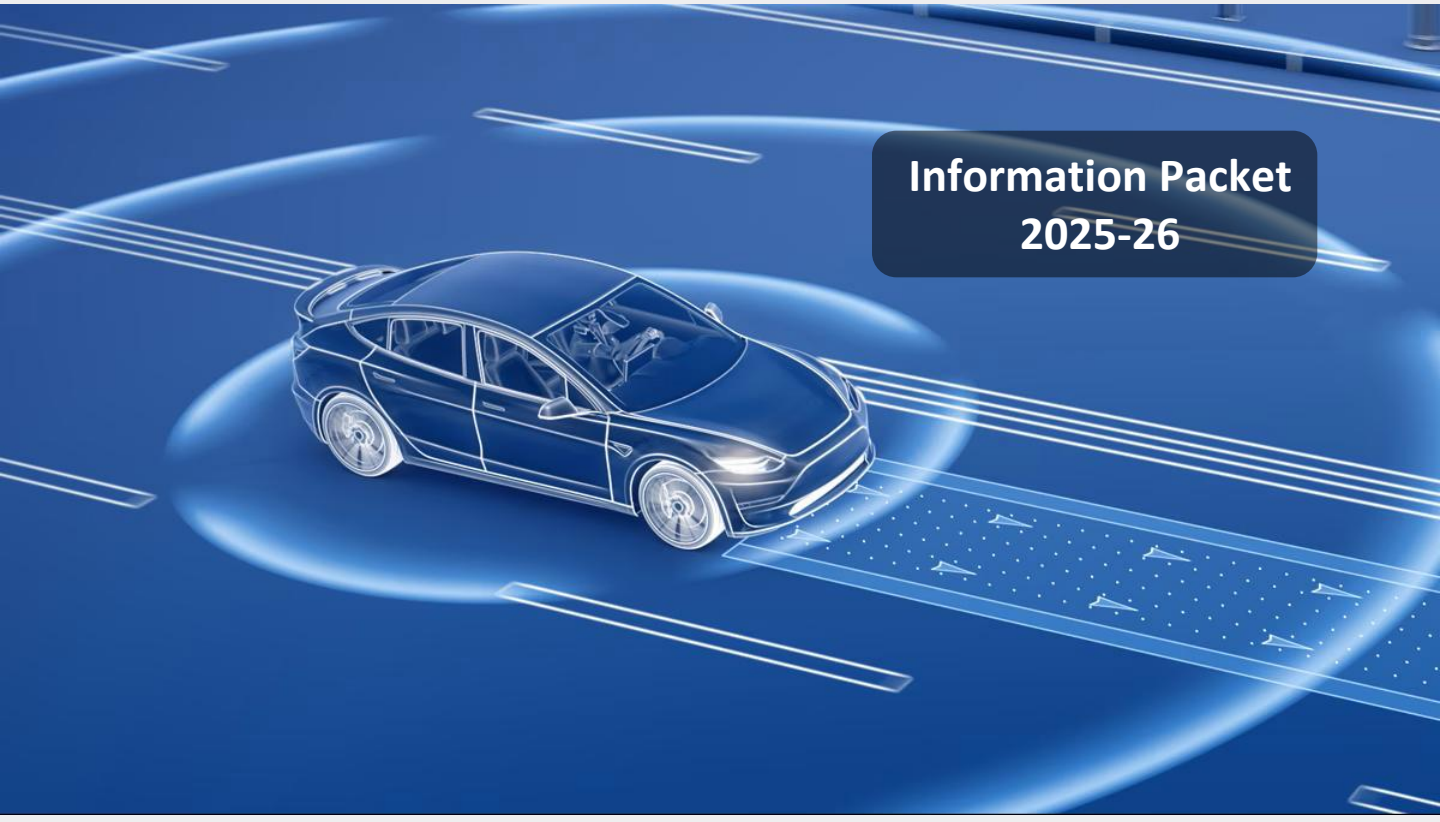
Technology Innovation & Product Support (TIPS)

AV - Autonomous Vehicles



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2000 2025
25 YEARS

Appreciate IARE students who are showing interest in the Autonomous Vehicles (AV) Project Program at the Institute of Aeronautical Engineering!

The AV project team comprises B.Tech students, research scholars, and faculty members collaboratively working on cutting-edge challenges in autonomous navigation, control systems, and sensor integration. This innovation theme focuses on designing intelligent mobility systems using AI, Machine Learning (ML), and Internet of Things (IoT) technologies. ML algorithms play a crucial role in real-time decision-making, object detection, lane tracking, path planning, and adaptive cruise control. These intelligent systems help vehicles perceive their environment, make safe navigation decisions, and adapt to dynamic road conditions. This project fosters the development of next-generation transport solutions, contributing to smart city infrastructure, reducing road accidents, and enhancing mobility for all.

Goals for Project Development in Autonomous Vehicles are

Design and Develop a Scalable Autonomous Navigation System
Create a modular prototype capable of safe and efficient self-driving using real-time sensor fusion and machine learning algorithms.

Integrate multi-Sensor Technologies
Combine data from LiDAR, ultrasonic sensors, GPS, and cameras to enable accurate environment perception and obstacle detection.

Implement Real-Time Decision-Making Algorithms
Develop ML-based models for adaptive cruise control, lane keeping, and collision avoidance to support autonomous decision-making.

Enhance Safety and Reliability
Ensure robust handling of uncertain road scenarios, including pedestrian crossings, traffic signals, and unstructured roads.

Create a User-Friendly Control and Monitoring Interface
Design a dashboard or mobile app to visualize vehicle data, issue manual overrides, and monitor performance remotely.

Ensure Energy Efficiency and Cost Optimization
Optimize power consumption and component selection to make the autonomous vehicle prototype affordable and sustainable.

Test and Validate in Realistic Environments
Deploy the prototype in semi-controlled environments to assess performance under diverse traffic and weather conditions.

Enable Customization for Targeted Applications
Allow flexibility to adapt the projectfor use in delivery systems, agriculture, campus shuttles, or disaster response vehicles.

The research theme of this AV project also focuses on the challenges presented by the Sustainable Development Goals (SDGs).

IARE Sustainability Development Goals (SDGs) highlighted with Blue Colour Font	
SDG #1	End poverty in all its forms everywhere
SDG #2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture

SDG #3	Ensure healthy lives and promote well-being for all at all ages
SDG #4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
SDG #5	Achieve gender equality and empower all women and girls
SDG #6	Ensure availability and sustainable management of water and sanitation for all
SDG #7	Ensure access to affordable, reliable, sustainable and modern energy for all
SDG #8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
SDG #9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
SDG #10	Reduce inequality within and among countries
SDG #11	Make cities and human settlements inclusive, safe, resilient and sustainable
SDG #12	Ensure sustainable consumption and production patterns
SDG #13	Take urgent action to combat climate change and its impacts
SDG #14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
SDG #15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
SDG #16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
SDG #17	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

The following research domains are recommended for Autonomous Vehicle projects, and selected students should find the research gap and frame the problem statements from any one of the themes below.

S.No	Name of the Theme	SDGs
1	Smart Navigation and Route Optimization Systems	SDG #11
2	Vision-Based Traffic Understanding and Compliance	SDG #9
3	Sustainable and Energy-Efficient Autonomous Delivery Systems	SDG #13

To participate in **Autonomous Vehicle Innovation Projects**, you must formally apply and be accepted by the project coordinator. To proceed, please contact the project coordinator, **Dr. Ranjith Kumar Gatla** (g.ranjith@iare.ac.in), Associate Professor, Department of CSE (DS). This process will help you explore all available open positions aligned with autonomous vehicle technologies.

When submitting your project proposal and updated résumé, please include a clear statement explaining why you are interested in contributing to the autonomous vehicle development team. Your motivation, along with any prior experience in robotics, embedded systems, or AI, will help determine team placement.

Please note that participation in the autonomous vehicle project development initiative requires registration under a valid research or design project title focused on key domains such as smart

mobility, self-driving systems, sensor integration, and AI-based route planning. More detailed information, guidelines, and deliverables will be shared with all selected applicants who are offered a position.

If you have any questions regarding a specific sub-project or specialization track, feel free to reach out to the assigned faculty mentor(s) for further clarification.

We strongly encourage you to explore this cutting-edge opportunity to work on real-world autonomous vehicle systems. We look forward to your application and the exciting innovations you will help build!

Smart Navigation and Route Optimization Systems

Dr. Ranjith Kumar Gatla, Associate Professor, CSE (DS), Faculty Mentor

GOALS

Smart Navigation and Route Optimization Systems aim to transform the way individuals and goods move across various environments—urban areas, industrial zones, logistics routes, and even indoor facilities. The overarching goals include enhancing travel efficiency, reducing fuel consumption and emissions, minimizing congestion, and ensuring timely arrivals by dynamically adjusting routes based on real-time conditions. These systems are essential for intelligent transportation systems (ITS), autonomous vehicles, fleet management, and emergency response planning.

Through integration with AI and real-time data feeds (e.g., GPS, traffic sensors), these systems optimize decision-making processes for navigation, taking into account variables like weather, traffic patterns, road closures, and driver behavior. In logistics and delivery sectors, the goal extends to ensuring on-time deliveries while minimizing operational costs.

METHODS & TECHNOLOGIES

Smart navigation systems employ various advanced methods such as:

Artificial Intelligence and Machine Learning: Used for predictive traffic modelling, dynamic route suggestions, and learning from historical traffic data.

Graph Theory and Optimization Algorithms: Algorithms like Dijkstra's, A*, and Ant Colony Optimization are used for shortest and most efficient path finding.

Computer Vision and LIDAR: In autonomous driving, these technologies help in lane detection, obstacle avoidance, and scene understanding.

Global Positioning Systems (GPS) and Geospatial Analytics: Real-time tracking and spatial analysis for optimal decision-making.

Edge Computing and IoT: For real-time sensor data processing in smart vehicles and traffic infrastructure.

V2X Communication (Vehicle-to-Everything): Enables vehicles to communicate with each other and with infrastructure to prevent collisions and optimize flow.

Technologies such as Google Maps API, HERE Maps, OpenStreetMap, and onboard vehicle infotainment systems power real-time navigation. For large fleets and autonomous systems, cloud-integrated dashboards and route analytics engines are commonly used.

MAJORS & AREAS OF INTEREST

This theme spans several interdisciplinary majors and fields, including:

Computer Science & Engineering

Focus areas: algorithm design, AI/ML models for prediction and optimization, real-time systems

Geoinformatics & Geographic Information Systems (GIS)

Focus areas: spatial data modeling, location-based services, geospatial analytics

Transportation Engineering & Urban Planning

Focus areas: traffic flow modeling, congestion management, smart mobility planning

Robotics & Autonomous Systems

Focus areas: real-time path planning, SLAM (Simultaneous Localization and Mapping), autonomous navigation

Data Science & Analytics

Focus areas: travel pattern prediction, anomaly detection in routes, optimization under uncertainty

Researchers and developers in this domain aim to enable intelligent mobility solutions whether for public transport systems, ride-hailing platforms, autonomous vehicles, or e-commerce delivery chains improving speed, safety, and sustainability.

MENTOR CONTACT INFORMATION

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PARTNERS & SPONSORS

None

Vision-Based Traffic Understanding and Compliance

Dr. Sajja Suneel, Assistant Professor, CSE (DS), Faculty Mentor

GOALS

Vision-Based Traffic Understanding and Compliance systems aim to enhance road safety, enforce traffic regulations, and optimize traffic management by utilizing computer vision and artificial intelligence technologies. These systems are designed to automatically interpret visual data from roadside and vehicle-mounted cameras to identify violations such as signal jumping, lane departures, speeding, and helmet or seatbelt non-compliance.

The overarching goals include improving compliance with traffic laws, reducing human intervention in enforcement, minimizing accidents, and enabling data-driven urban planning. By automating traffic monitoring and violation detection, these systems contribute to more efficient, fair, and scalable traffic governance frameworks.

METHODS & TECHNOLOGIES

Key methods and technologies used in vision-based traffic understanding include:

Computer Vision and Image Processing: Detect and track vehicles, recognize license plates, and monitor behavior in real-time.

Deep Learning: Used for object detection, classification, and segmentation of road users and signs.

Optical Character Recognition (OCR): For automatic number plate recognition (ANPR).

Video Analytics and Motion Tracking: Analyzes video frames to identify anomalies, violations, or congestion patterns.

Edge Computing and IoT Integration: Enables on-site processing of camera data for faster response times.

Cloud-Based Data Storage and Dashboards: Support centralized violation reporting, analytics, and urban traffic trend visualization.

Technologies include CCTV surveillance systems, smart cameras, Raspberry Pi with vision modules, TensorFlow, OpenCV, and cloud platforms such as AWS or Azure for real-time analytics.

MAJORS & AREAS OF INTEREST

This domain intersects multiple majors and interest areas, including:

Computer Science & Artificial Intelligence

Focus areas: deep learning for object detection, real-time vision systems, AI-based decision support

Electronics & Communication Engineering

Focus areas: smart camera design, embedded vision systems, sensor integration

Transportation Engineering

Focus areas: traffic behavior modeling, road safety analysis, compliance monitoring systems

Data Science & Urban Informatics

Focus areas: violation pattern analysis, predictive traffic behavior, policy optimization

Law Enforcement and Public Policy

Focus areas: automated traffic law enforcement, surveillance ethics, smart governance

Through interdisciplinary collaboration, these systems offer smart, scalable, and effective solutions for real-time traffic monitoring and compliance enforcement, contributing to safer roads and smarter cities.

MENTOR CONTACT INFORMATION

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PARTNERS & SPONSORS

None

Sustainable and Energy-Efficient Autonomous Delivery Systems

Dr. Damodhar Reddy, Professor & Head, EEE, Faculty Mentor

GOALS

The goal of Sustainable and Energy-Efficient Autonomous Delivery Systems is to revolutionize last-mile logistics with minimal environmental impact. These systems are developed to deliver packages within defined areas—such as campuses, gated communities, or urban sectors—using autonomous robots that are powered by renewable energy or optimized battery systems.

Primary objectives include reducing carbon emissions in logistics, minimizing delivery costs, and enabling scalable, zero-emission delivery frameworks. These systems aim to offer a dependable, low-maintenance alternative to human-led delivery by integrating solar panels, real-time navigation, and automated delivery confirmation processes.

METHODS & TECHNOLOGIES

Key methods and technologies used in this theme include:

Renewable Energy Integration: Solar panels and efficient battery systems to power delivery robots sustainably.

Autonomous Navigation: GPS-based routing, point-to-point mapping, and SLAM (Simultaneous Localization and Mapping) for path planning.

Lightweight and Modular Robotic Design: For enhanced mobility and energy efficiency with minimal material usage.

Obstacle Detection and Avoidance: Using ultrasonic sensors, IR sensors, and computer vision for safe movement.

IoT and Real-Time Monitoring: Cloud-based dashboards for tracking, delivery updates, and status reporting.

Delivery Confirmation Systems: Barcode scanning, OTP verification, or mobile alerts to ensure successful package handover.

Technologies include microcontrollers (Arduino/Raspberry Pi), solar charging circuits, motor controllers, GPS modules, and integration with web/mobile platforms.

MAJORS & AREAS OF INTEREST

This theme brings together disciplines focused on green technology, autonomous systems, and robotics:

Robotics & Embedded Systems
Focus areas: robot design, embedded hardware-software integration, automation control

Electrical & Renewable Energy Engineering
Focus areas: solar energy systems, battery management, power optimization

Computer Science & Artificial Intelligence
Focus areas: autonomous navigation, AI-driven obstacle avoidance, intelligent routing

Internet of Things (IoT) & Communication Systems
Focus areas: real-time data exchange, delivery status alerts, cloud-based system integration

Urban Mobility and Sustainable Logistics

Focus areas: zero-emission transport, last-mile delivery innovation, smart city deployment

With a strong emphasis on energy efficiency, sustainability, and intelligent automation, this system envisions the future of eco-friendly delivery operations in urban and semi-urban environments.

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PARTNERS & SPONSORS

None