Intelligent Moving Cities

Korea-EU Horizon Europe Researchers Networking Forum

on Advanced Mobility

Presenter

University of Seoul / University of Cambridge

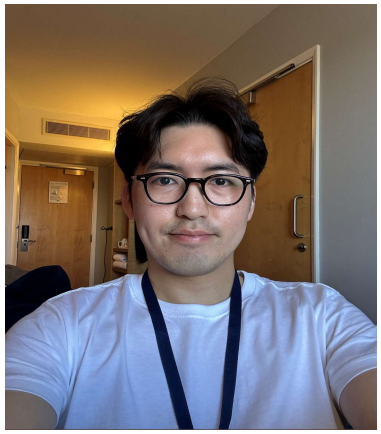
Research Professor / Academic Researcher (Postdoc Res.)

Minje Choi

1 Introduction

1.1 Research on Autonomous Robots and Smart Mobility

✔ Research on **autonomous mobility, urban-scale simulation, and human–robot interaction** for smart and sustainable cities.



📍 Current Positions

- Research Professor, University of Seoul (2023~)
- Academic Researcher, University of Cambridge (Dept. of Land Economy) (2025~)

🎓 Education

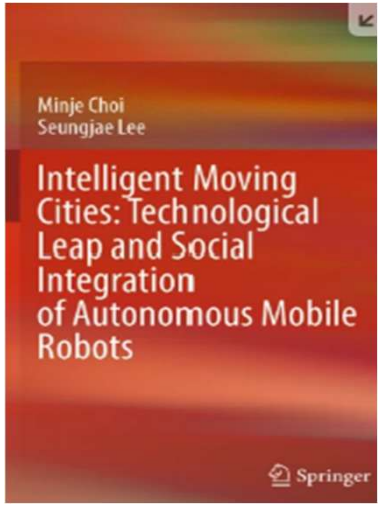
- Ph.D. in Transportation Engineering, University of Seoul (2023.08)

💼 Professional Roles

- Committee Member, **Ministry of Land, Infrastructure and Transport (MOLIT) Autonomous Vehicle Pilot Operation Zone** (2025–)
- Founder & CEO, RaaSS Co., Ltd. (Autonomous Robot Systems Startup) (2022~)
- Principal Investigator, National R&D Projects on **Autonomous Robots** and **Autonomous Mobility Systems**

📚 Research & Achievements

- **21+ SCIE/SSCI** papers over the past 4 years, **1 International Books (Springer Nature)**
- 10 Patents (Autonomous Robots, Walkability, Smart Mobility)
- 2025 BK21 Minister of Education Award (Korea)
- **2024 James Hill Prize** (UK, Institution of Civil Engineers)



🌐 Research Interests

Autonomous Driving • Autonomous Robots • Mobility Planning • Walkability

1.2 University of Seoul and the City's Readiness for Advanced Mobility Demonstration

- **The University of Seoul is strongly supported by the Seoul Metropolitan Government**, creating an open environment for collaboration on future mobility demonstrations
- **Seoul is already operating autonomous driving testbeds** in dense urban areas such as Sangam and Gangnam, paving the way for real-world innovation
- **As a national committee member for autonomous vehicle testbeds**, I also contribute to policy decisions accelerating Korea's mobility innovation

Autonomous Driving Testbeds in Korea

University of Seoul – City-Supported Innovation Hub

1.3 Ongoing National R&D and International Collaboration

- **Leading national R&D projects on AI-driven digital twins and autonomous mobility**, in collaboration with global partners including Cambridge, UCL, and MIT.
- Research focuses on human-centered AI, precise positioning, and advanced navigation for future smart cities.

Current International Joint R&D Projects (3 projects, total budget USD 1.6 million)

1. Developing generative AI-based digital twin systems that promote pedestrian activity and urban walkability

2. Enhancing positioning technology for autonomous vehicles, achieving sub–0.5 m accuracy using 3D mapping and overbounding correction

3. Advancing autonomous sidewalk navigation, integrating image-based learning with the D* algorithm for efficient obstacle detection and path planning

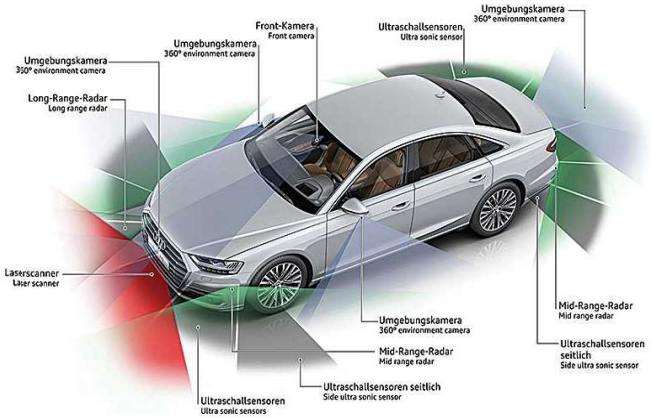
1.4 Research Focus and Applications

- Research has focused on three areas: **autonomous robots, autonomous driving systems, and urban mobility applications**
- Key themes include coexistence, integration, and sustainable urban transformation.

Autonomous mobile robots

Forms the backbone to enable seamless interaction with the physical environment

Autonomous driving systems



Source : Audi

Enables intelligent decision-making through advanced data processing and algorithm execution

Urban mobility applications

Source : Hyundai

Focuses on integrating systems within urban infrastructure and planning

2.1 Autonomous Mobile Robots: Toward Integrated Future Mobility

- Autonomous mobile robots play a key role in expanding autonomous driving toward integrated mobility across both roads and pedestrian spaces.
- Our research focuses on the versatility and real-world applicability of these systems through ROS-based development and testing. Autonomous mobile robots play a key role in expanding autonomous driving toward integrated mobility across both roads and pedestrian spaces.
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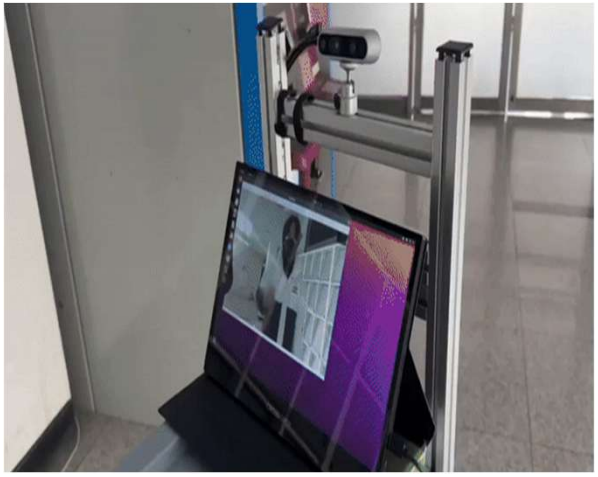
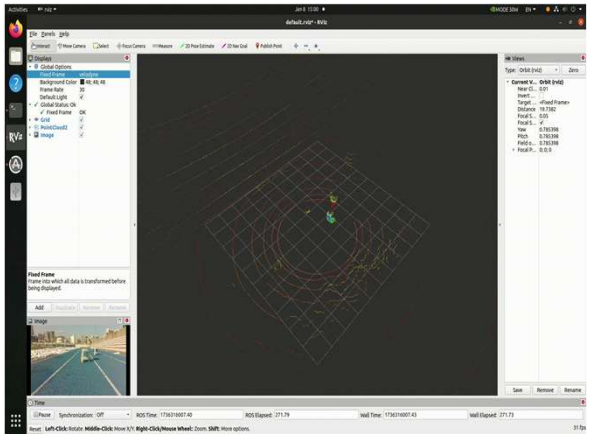
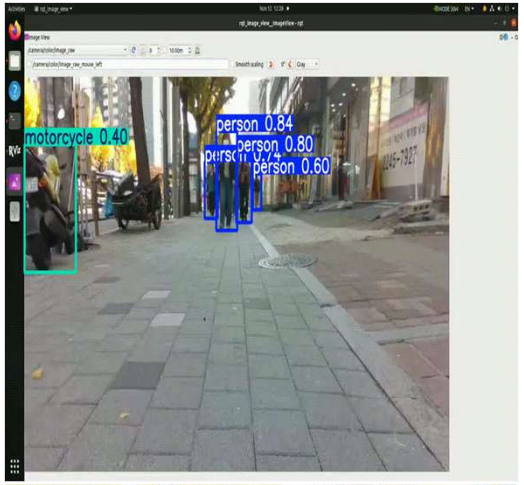
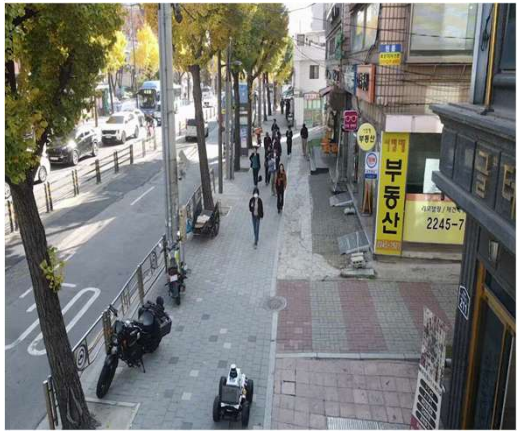






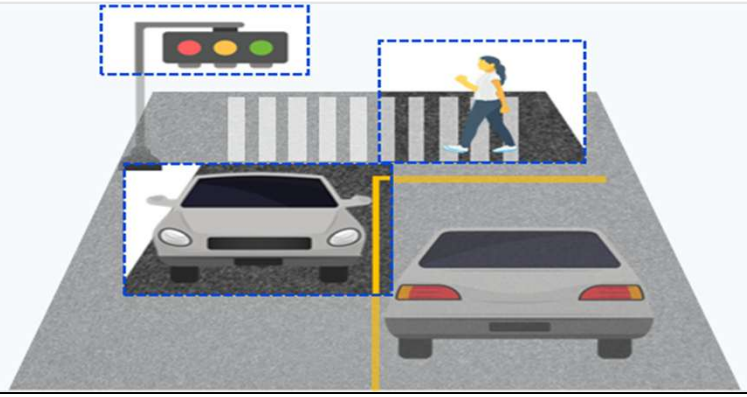


2.2 Autonomous Sidewalk Navigation: Understanding Complexity Beyond Roads

- Unlike roads, sidewalks have no fixed rules — they are full of unpredictable obstacles and human behaviors.
- To build an integrated autonomous mobility system, we must understand and model the unique characteristics of pedestrian spaces.

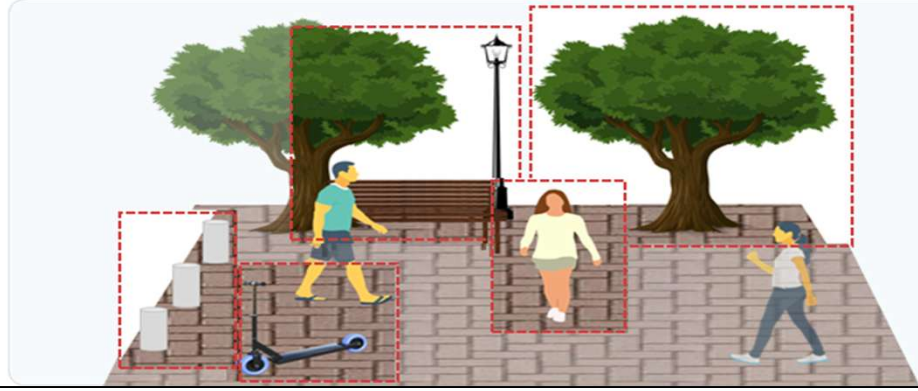
Autonomous Driving Systems on Roads

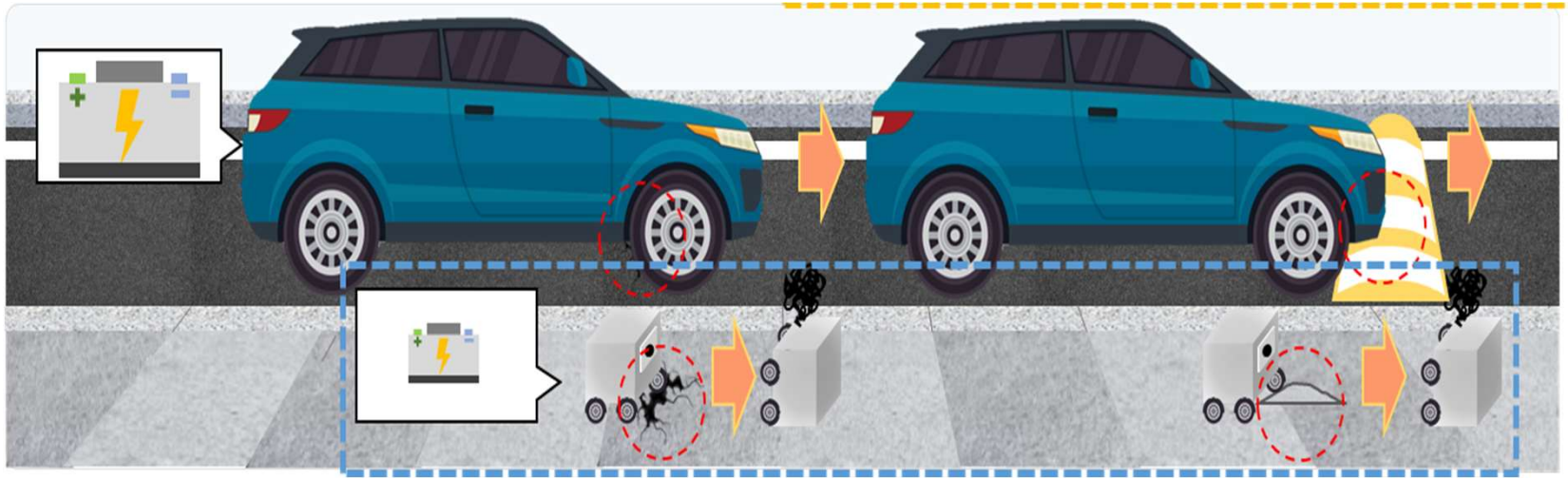
- Aim to reach the destination at minimum cost
- Consider temporary elements such as traffic lights, pedestrians, and nearby vehicles



Autonomous Driving Systems on Sidewalks

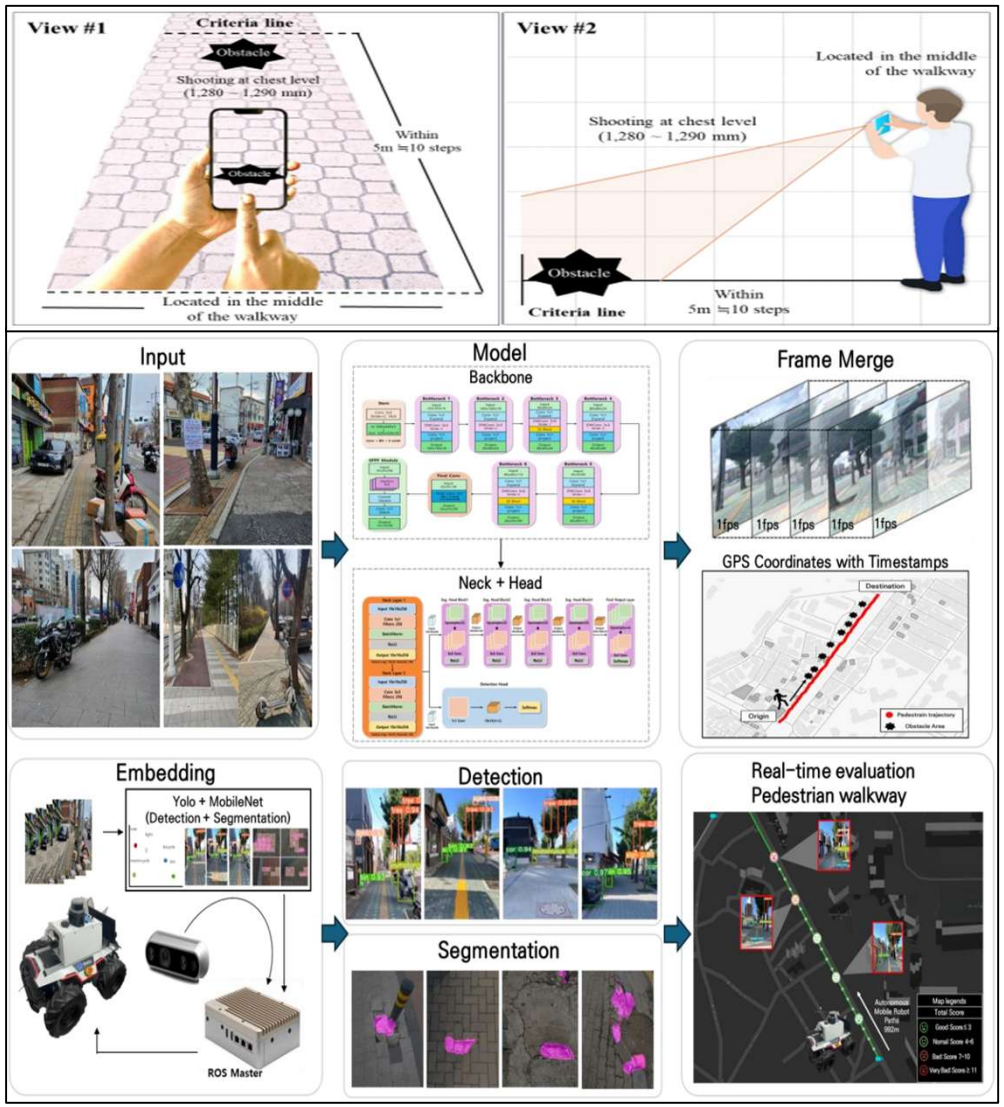
- Pedestrians move in random directions
- Consider recurring elements such as pedestrians, trees, benches, and streetlights

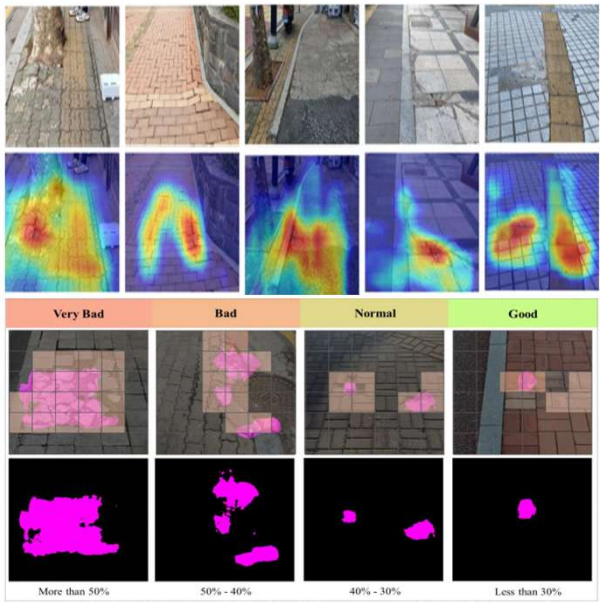




2.3 Deep Learning-Based Sidewalk Perception and Mapping System *(Research Gap)*

- **Collected over 500,000+ sidewalk images** across Seoul to capture diverse pedestrian environments
- **Developed an AI-based perception system** that enables robots to re-collect and analyze real sidewalk conditions





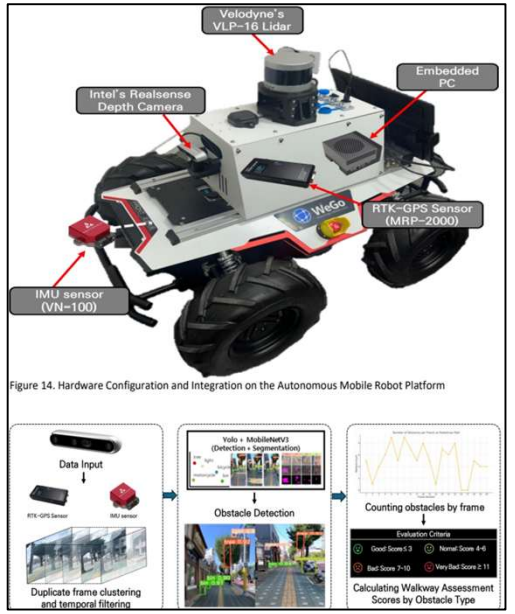
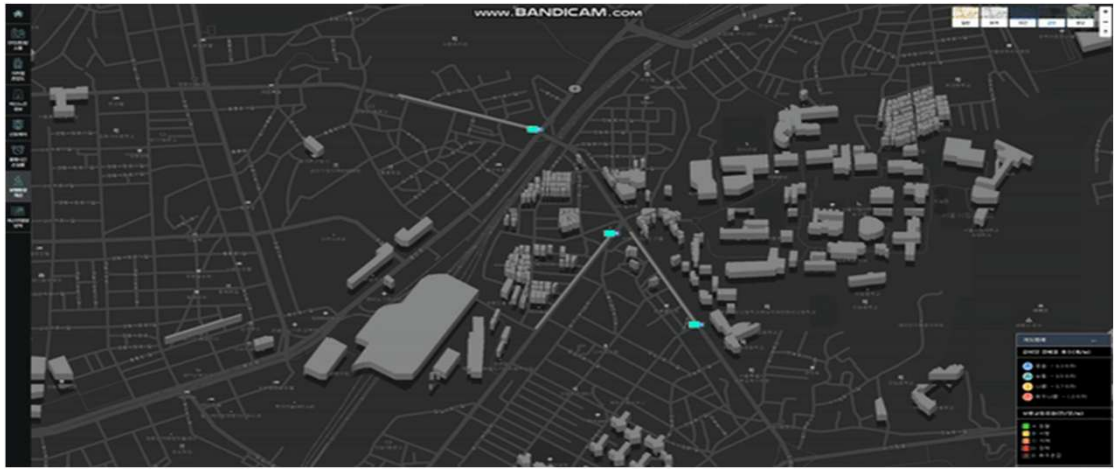


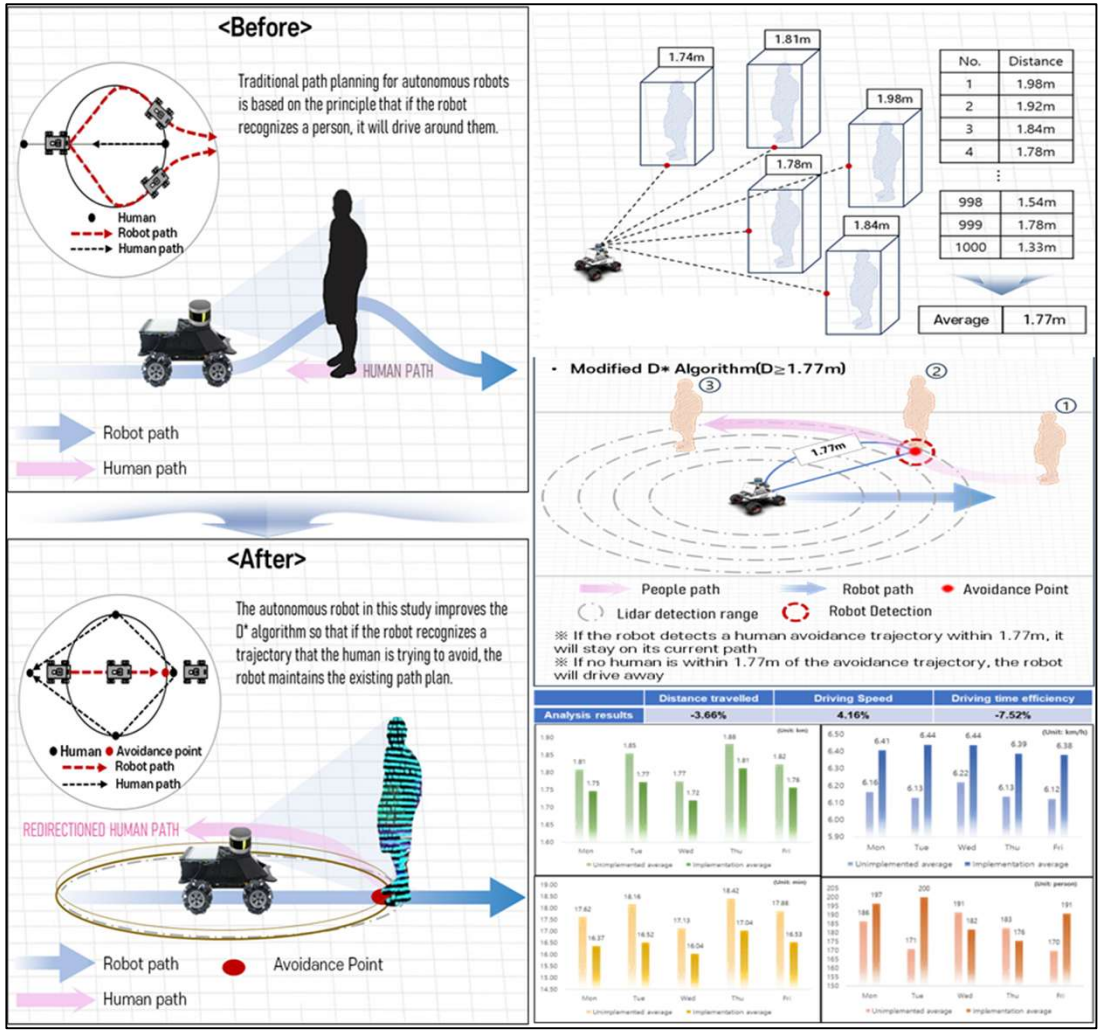
Figure 14. Hardware Configuration and Integration on the Autonomous Mobile Robot Platform



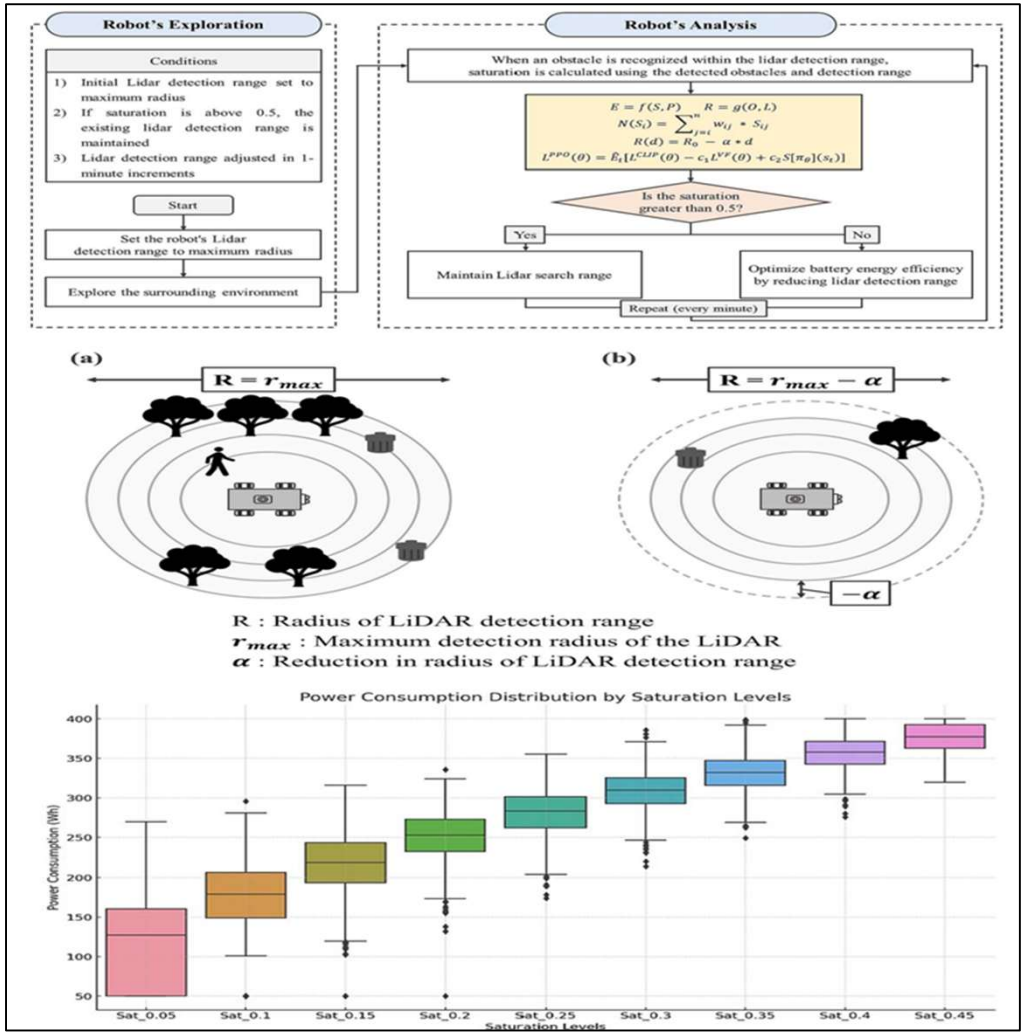
2.4 System Research for Autonomous Robots *(Research Gap)*

- Conducted research on **optimal path planning for autonomous robots** on sidewalks
- Studies include **trajectory-based optimization** using human movement data and **energy-efficient routing** by evaluating obstacle density

Setting up avoidance points and modifying D* algorithms through trajectory data analysis
(Choi.et.al, 2024)



Energy-efficient routing by evaluating obstacle density
(Choi.et.al, 2024)

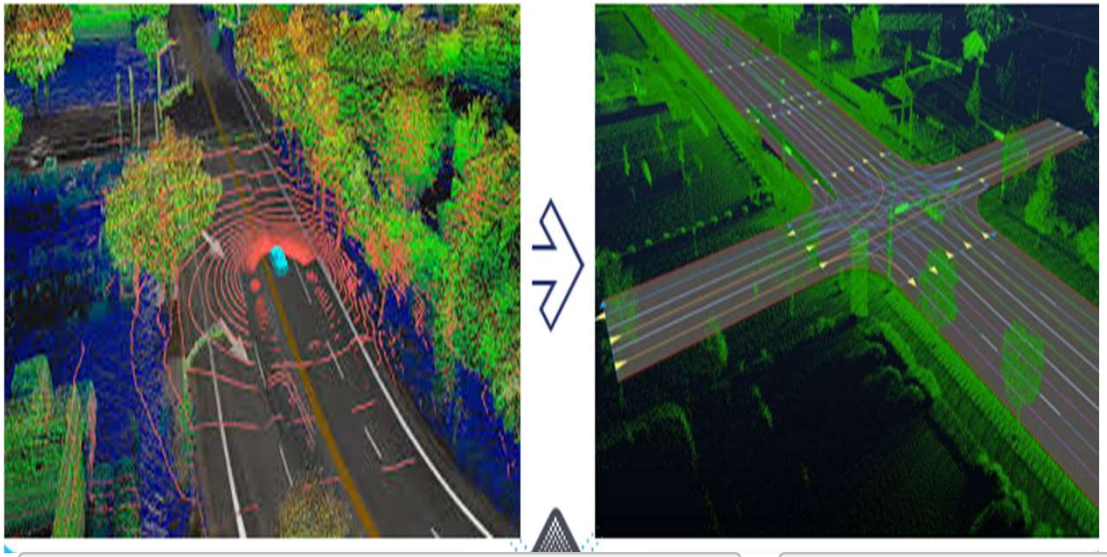


3 Research of Autonomous Driving Systems

3.1 Lightweight Positioning System for Autonomous Driving *(Research Gap)*

- Developing an advanced positioning algorithm that extracts only minimal 3D map features for fast and efficient localization.
- Achieves high accuracy and reliability while reducing computational load within autonomous driving systems.

Efficiency of positioning with minimum data

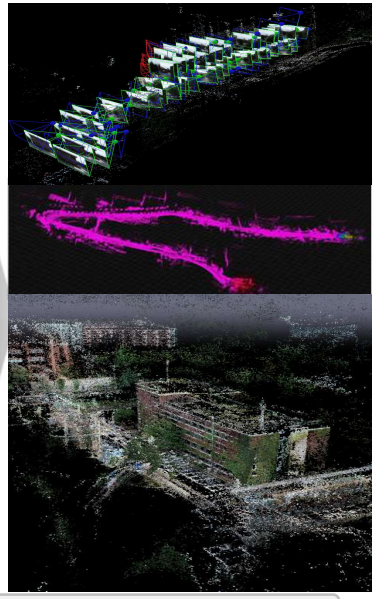


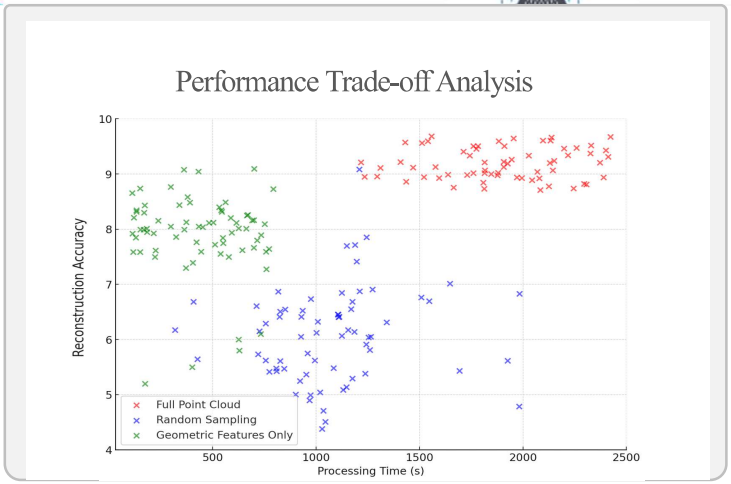
1. Multi-Sensor-Based Optimal Path Design

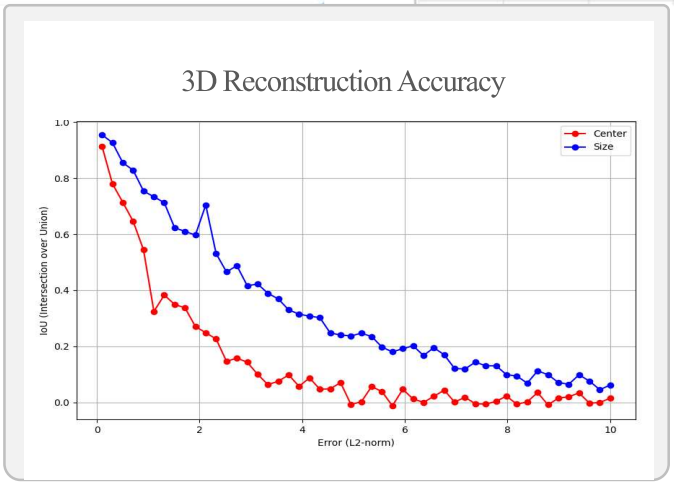
2. Collection of target area aviation data

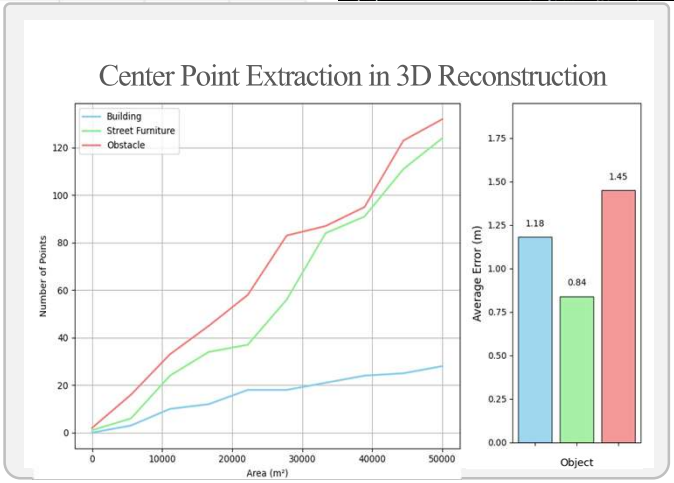
위도 [deg]	경도 [deg]	고도 [m]	정확성 수평 [m]	정확성 수직 [m]	오머가 [degree]	Phi [degree]
37.58483489	27.06083267	62.176	1.746	6.449	90.00000	-85.08305
37.58481819	127.06077808	61.351	1.814	7.731	90.00000	-84.98309
37.58480836	127.06065614	59.104	1.713	7.715	90.00000	-85.18316
37.58482886	127.06062492	60.422	1.623	7.038	90.00000	-85.18318

3. Correction of spatial distortion







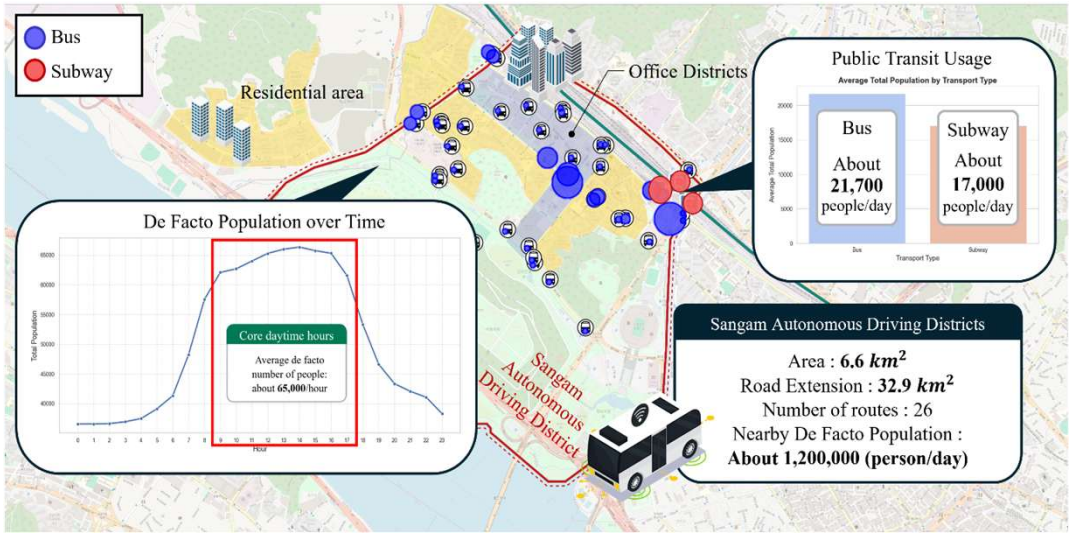


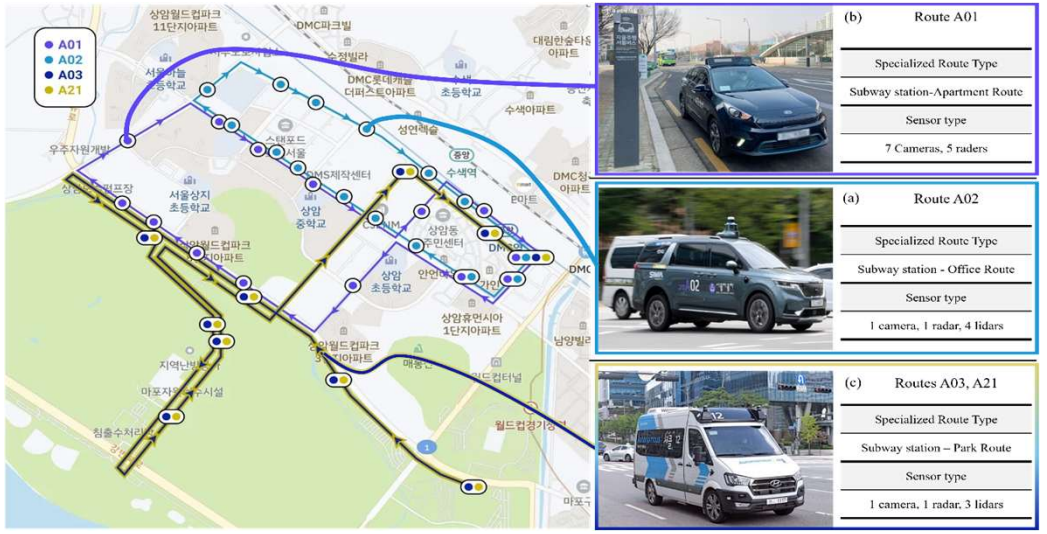
3 Research of Autonomous Driving Systems

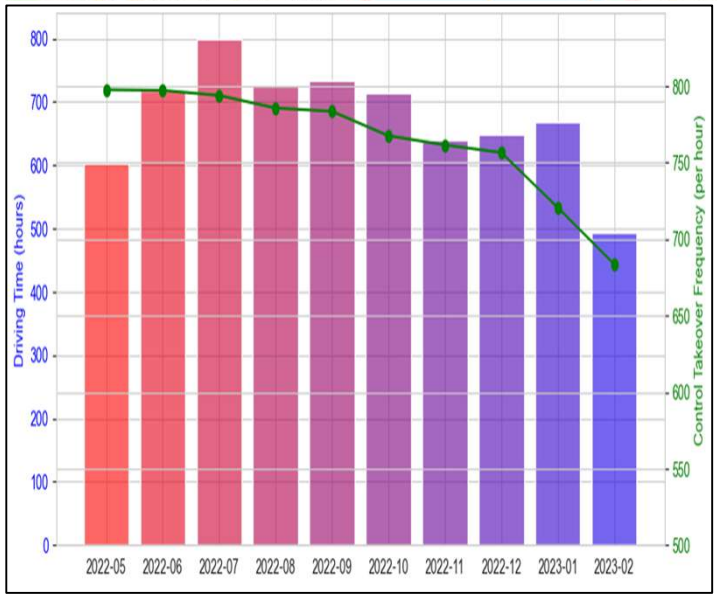
3.2 Understanding Control Transitions through Real-World Autonomous Driving Data *(Research Gap)*

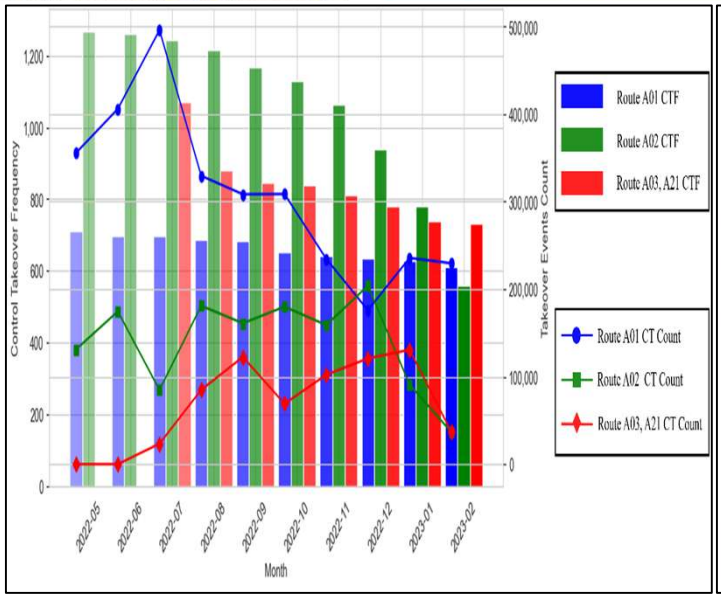
- **Analyzed one year of autonomous driving data** in Seoul to identify when and why control transitions occur.
- The study reveals **how infrastructure conditions influence safe handovers** between humans and autonomous systems.

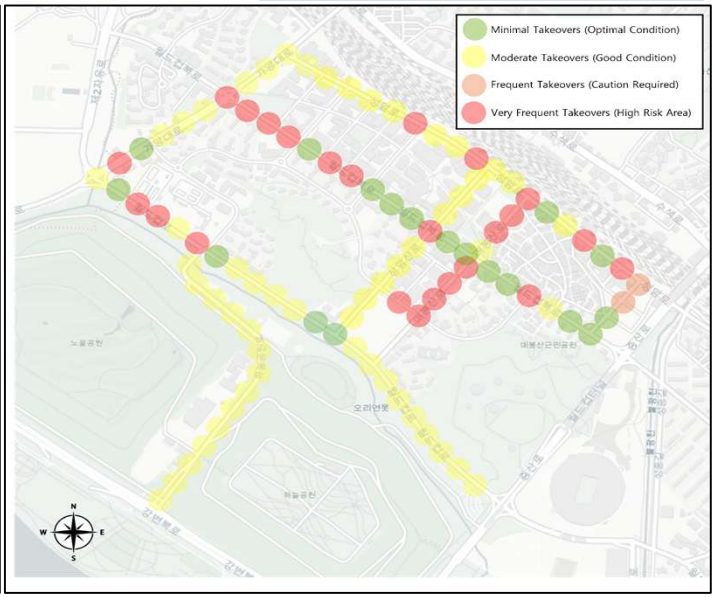
Introduction of Autonomous Driving District and Data Analysis Results









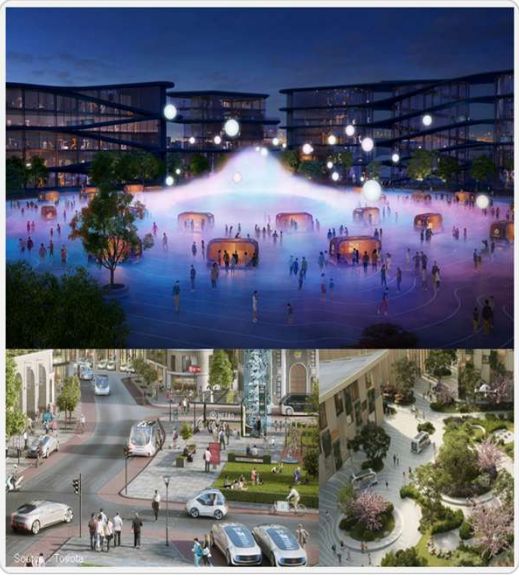


4 Research of Urban mobility applications

4.1 Urban Mobility Applications and Future Impacts

- Autonomous mobility technologies truly create value **when integrated into real cities**
- **Evaluating their urban impacts and planning future mobility ecosystems** are essential for sustainable development.

Toyota Woven City (CES 2025) , Hyundai Gwangmyeong-Siheung Future Mobility City (2024)

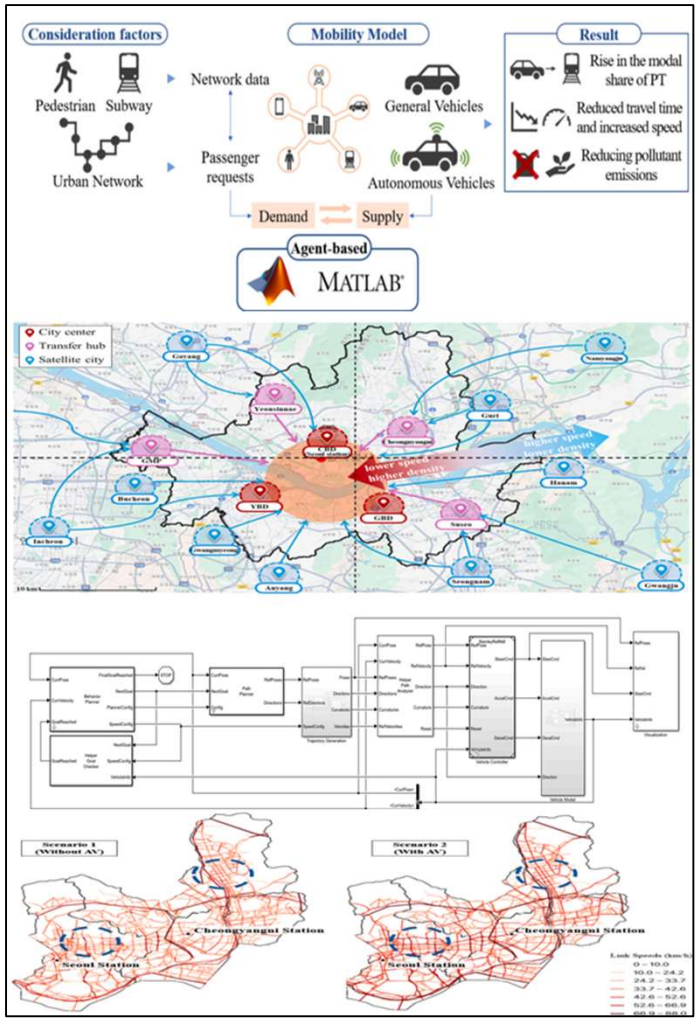


4 Research of Urban mobility applications

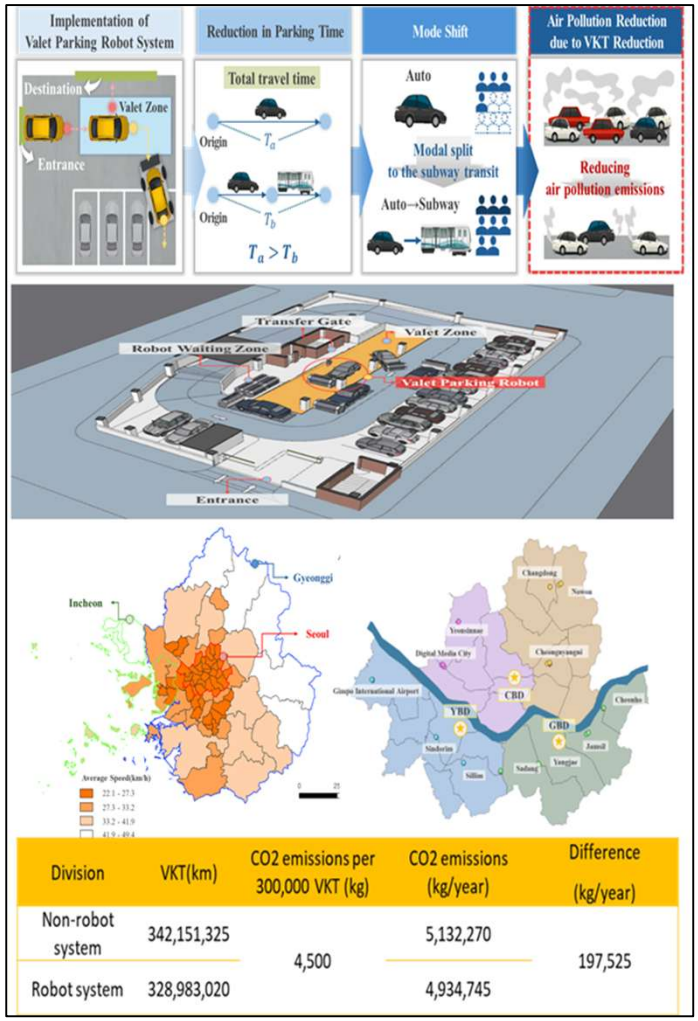
4.2 Quantifying the Urban Impacts of Autonomous Mobility *(Research Gap)*

- To justify the **introduction of autonomous mobility, evidence is essential** — both for policymakers and the public.
- **Our studies simulated how autonomous systems** integrate with cities and demonstrated measurable impacts on congestion, environment, and efficiency.

Optimization Strategies by AV Penetration Levels
(Choi et al, 2025)

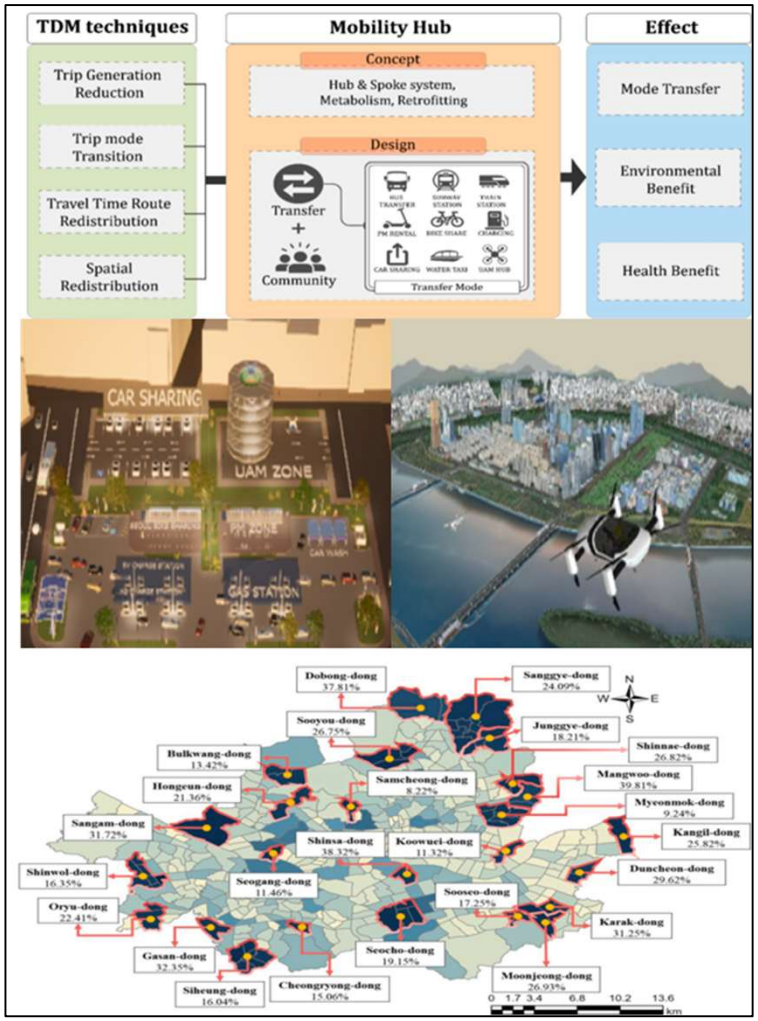


Autonomous Parking Robots in Urban
(Choi et al, 2024)



Division	VKT(km)	CO2 emissions per 300,000 VKT (kg)	CO2 emissions (kg/year)	Difference (kg/year)
Non-robot system	342,151,325	4,500	5,132,270	197,525
Robot system	328,983,020		4,934,745	

Mobility Hubs for Integrated Urban Mobility
(Ku et al, 2022)



5 Horizon Europe & Joint Research Opportunities

5.1 Proposed Horizon Europe Projects & Our Strengths

- With strong city support, real urban testbeds, and expertise in AI-based simulation and policy integration, the University of Seoul bridges technology, data, and urban application.
- We contribute by linking research and **real-world validation, connecting autonomous systems, smart mobility, and city-scale planning.**

HORIZON-CL5-2026-10-D6-01:
Flagship-pilot: Large-scale Demonstrations of CCAM

Main Objectives:

- Integrate and demonstrate advanced CCAM technologies in real urban environments.
- Validate safety, efficiency, and public trust through multi-site testing.
- Develop policy and business models for large-scale deployment.

Our Idea Briefly Explained:
Using Seoul's real mobility testbeds, the project aims to create a city-scale simulation–demonstration framework that connects AI-based perception, infrastructure data, and citizen behavior modeling to evaluate how CCAM systems can operate effectively in dense urban environments.

HORIZON-CL5-2026-10-D6-02:
Geopolitical competition and socioeconomic resilience in CCAM

Main Objectives:

- Assess Europe's global CCAM competitiveness and dependencies.
- Analyze socioeconomic impacts of CCAM adoption across sectors.
- Build an innovation and policy roadmap to enhance resilience.

Our Idea Briefly Explained:
By integrating economic–transport modeling and urban digital twins, the project evaluates the long-term impacts of CCAM on employment, equity, and regional growth, providing an evidence-based roadmap for sustainable and inclusive mobility policy.

HORIZON-CL5-2027-06-D6-04:
Holistic Solutions for CCAM Integration in Critical Scenarios

Main Objectives:

- Identify and classify critical edge cases for CCAM operations.
- Develop AI-driven decision support for real-time risk management.
- Strengthen cooperation between road authorities, mobility operators, and emergency services.

Our Idea Briefly Explained:
The project designs a Digital Twin-based "Local Deconflicting CCAM Architecture" that detects, predicts, and mitigates risk scenarios (e.g., accidents, extreme weather, or system failures) while maintaining safety and continuity in complex urban environments.

HORIZON-CL5-2026-10-D6-10:
Enhanced Resilience in Multimodal Passenger Transport through Digital Technologies and AI

Main Objectives:

- Improve resilience of multimodal passenger systems using AI and digital twins.
- Enable predictive maintenance and real-time disruption management.
- Enhance passenger safety, reliability, and network efficiency.

Our Idea Briefly Explained:
Leveraging Seoul's multimodal data and AI simulation capabilities, the project develops a Generative AI–driven platform for predicting disruptions, optimizing network recovery, and improving resilience in multimodal corridors linking bus, metro, and shared mobility.

5.2 Our European Collaboration Network

- We are collaborating with **Prof. Galia Weidl from TH Aschaffenburg in Germany, focusing on LiDAR-based urban sensing and smart city analysis.**
- Together with **Prof. Boglárka Eisinger from Széchenyi István University in Győr, Hungary, we are building a strong alliance for Horizon Europe on large-scale autonomous mobility demonstrations.**

1. Our Expertise & Role & Strengths

Research focus on :

- *Autonomous mobility systems*
- *Urban-scale simulations (Digital Twin)*
- *Multi-agent & ROS-based robotics*
- *Policy & regulatory impact analysis*

Seoul City Testbeds provide real-world environments for validation and urban-scale simulation.

2. Existing Collaborations

- TH Aschaffenburg (Germany) – Expertise in sensor integration, system perception, and experimental testing.

- Széchenyi István University, Győr (Hungary) – Strong in large-scale AV demonstrations, hardware development, and testing at ZalaZONE.

3. Looking for partners

- focusing on **hardware design, AI-based mobility software, and public/private mobility applications, transport operators etc**

Thank you

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