

TIER IV

2022 / 03 / 10

Proposal for ConOps and OpsCons of
the AWF Bus ODD demonstration system
2nd draft

Daisuke Hashimoto

Agenda

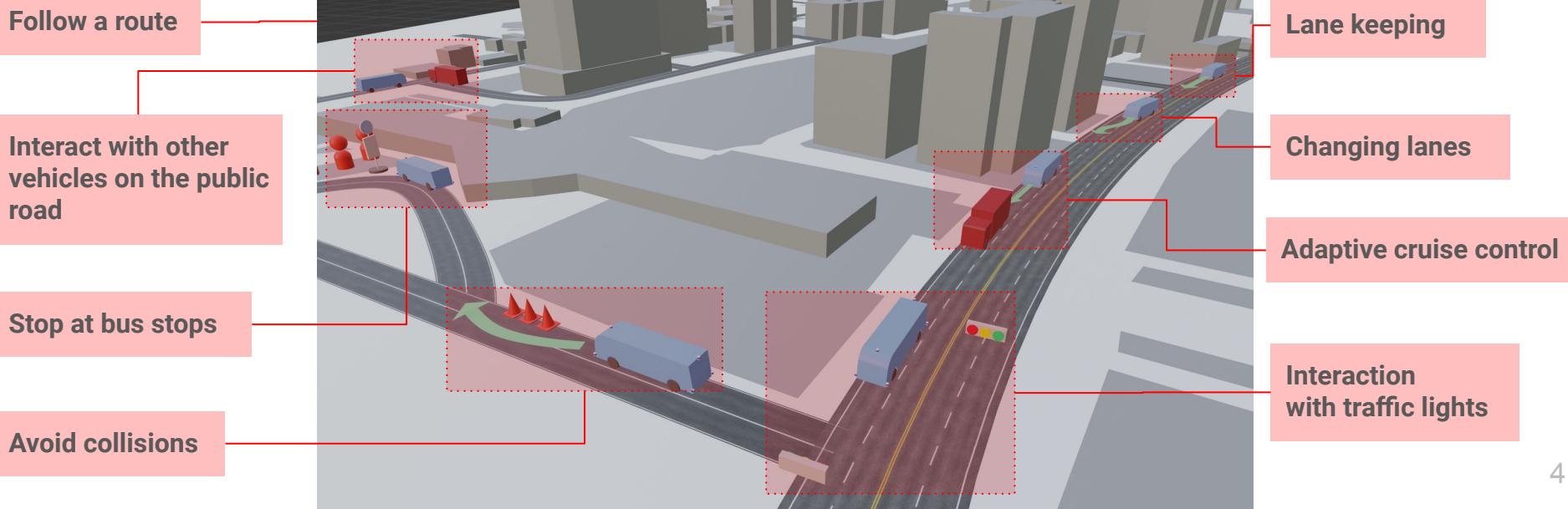
1. Purpose of this document
2. Concept of Operations (ConOps)
3. Operational Concepts (OpsCons)
4. OpsCons and correlated functions

1. Purpose of this document

- To help all AWF members understand the system that they are supposed to develop, Tier IV recommends developing ConOps and OpsCon of the system.
- This document proposes ConOps and OpsCons of the system that AWF is supposed to develop for the Bus ODD Demonstration.
- **This document is the starting point to discuss and clarify the scope of the demonstration.**
- NOTE: this is a draft version. There are concepts that should be discussed.

2. Concept of Operations (ConOps)

- **Passenger Transportation System in the urban area in Taiwan:**
 - The system, under the surveillance of an in-car operator, will automatically transport passengers while following routes on public roads. The public roads have multiple lanes, traffic lights, and intersections; therefore the system will automatically change lanes and respond to traffic lights at intersections. The system will automatically stop at bus stops. The system is programmed to avoid colliding with objects that are detected on the road. The vehicle is programmed to either safely pass the object when possible, or to stop. While the vehicle is moving, the system automatically maintains a safe following distance and stays within the speed limit (i.e., adaptive cruise control).

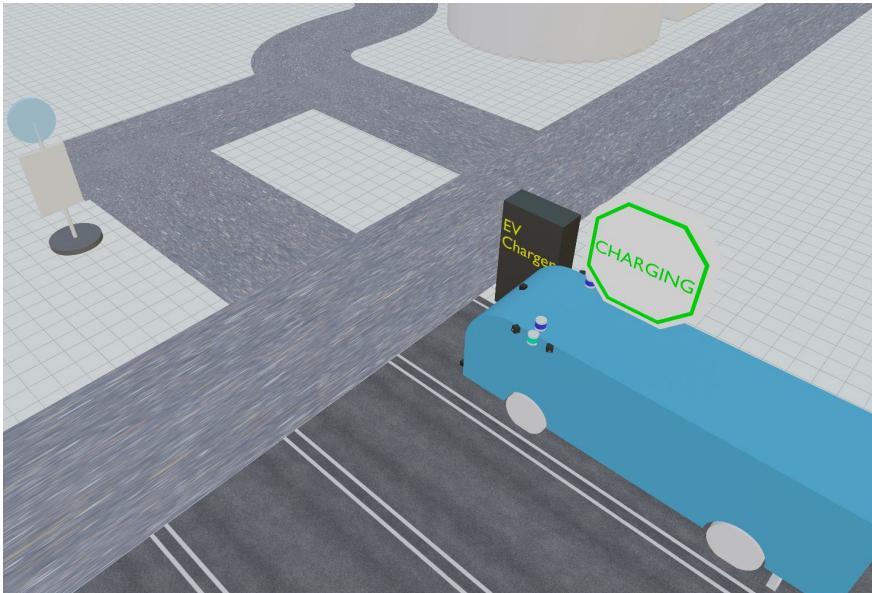


3. Operational Concept (OpsCon)

- OpsCons of Passenger Transportation System in the urban area in Taiwan
 1. Daytime Operation **[UPDATED]**
 2. Nighttime Operation **[UPDATED]**
 3. Follow a route
 4. Let passengers on and off at bus stops **[UPDATED]**
 5. Avoid collisions
 6. Set service route via HMI on the vehicle **[UPDATED]**
 7. Interact with other vehicles on the public roads
 8. Interact with traffic lights
 9. Operation Mode: Automatic/Manual
 10. Take over request to the operator **[to be discussed]**
 11. Lane keeping and changing lanes
 12. Adaptive cruise control
 13. Predict pedestrian stepping into the road

3.1. Daytime Operation [UPDATED]

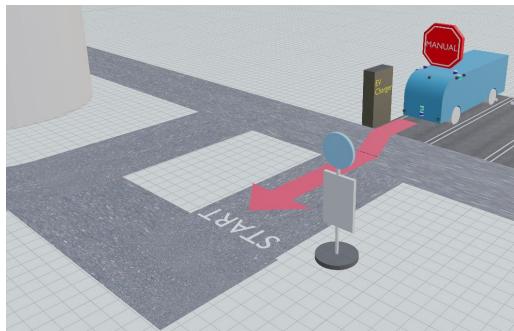
- Currently, the system does **NOT** operate in the daytime.
- In the future, the system will be able to operate during the daytime (9:30am - 3:30pm).
- The vehicle will be fully charged before the operation in the daytime.



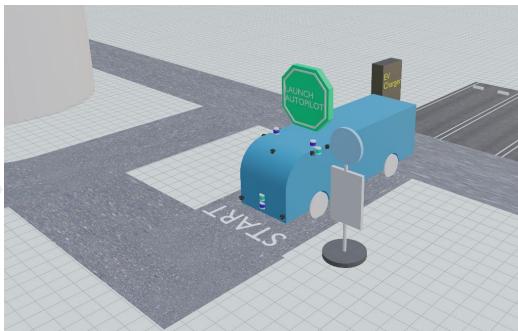
The operator connects the charger to the vehicle, and the vehicle is automatically charged

3.2. Nighttime Operation [UPDATED]

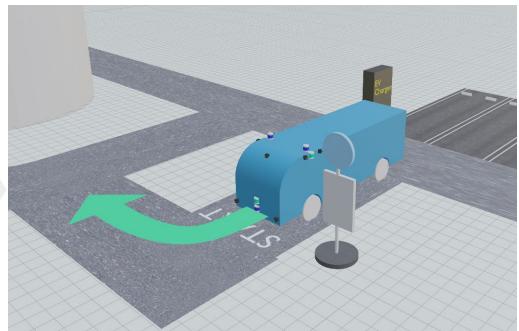
- During the nighttime (10pm - 1am), an in-car operator drives the vehicle from a parking lot to a start position and manually launches the autonomous driving system via HMI in the vehicle.
- The system starts moving automatically on a route set by the in-car operator.
- The in-car operator is while the system automatically operates.



1. The operator drives the vehicle from a parking to a start point



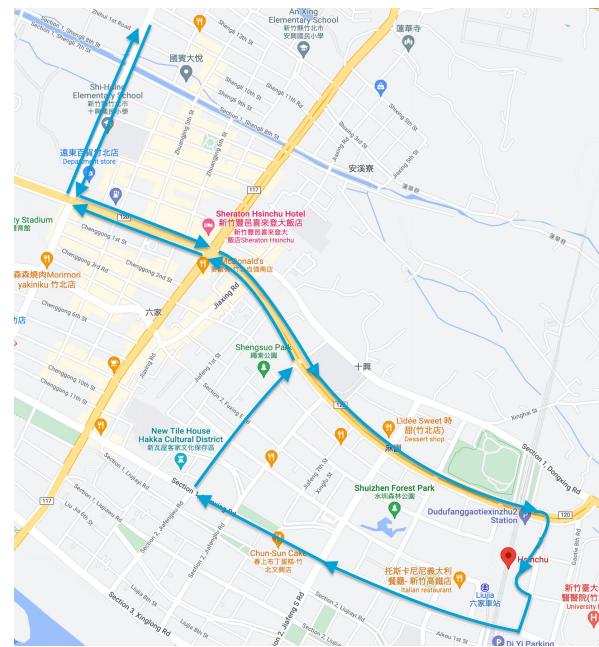
2. The operator launches the autonomous driving system



3. The vehicle automatically moves on a designated route

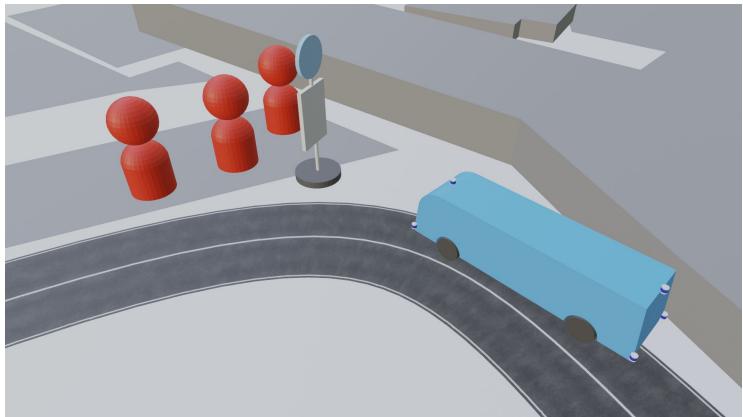
3.3. Follow a route

- The system follows a route set on the public road while an in-car operator is in the autonomous driving vehicle of the system.

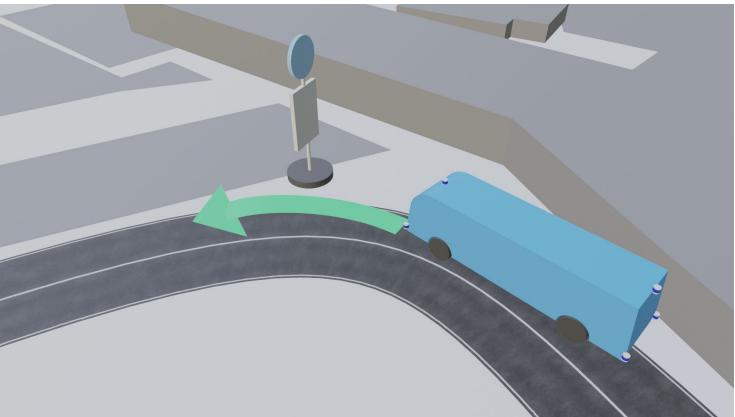


3.4. Let passengers on and off at bus stops [UPDATED]

- The system stops at bus stops set by the in-car operator.
- The in-car operator manually opens and closes the door of the vehicle to let passengers on and off at bus stops **due to the Hsinchu county government's request.**
- After the in-car operator requests the system to depart, the system automatically resumes driving along the route.



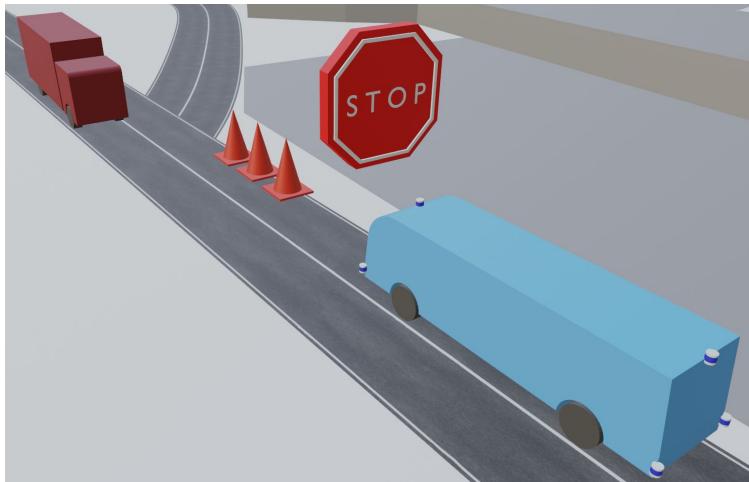
1. The vehicle automatically stops at each bus stop



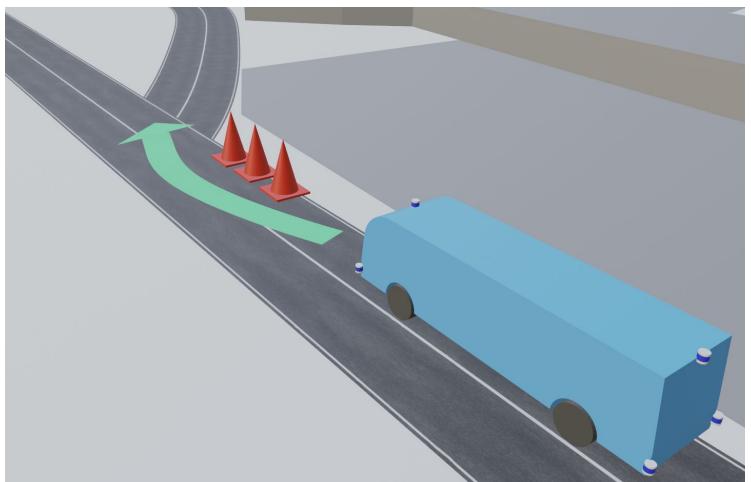
2. The operator requests the system to depart, and the system automatically resumes the operation

3.5. Avoid collisions

- When there are objects on the route, the system will automatically perform the following actions:
 - The system automatically stops if there is surrounding traffic.
 - The system automatically avoids the objects if there is no surrounding traffic.



a. The system stops



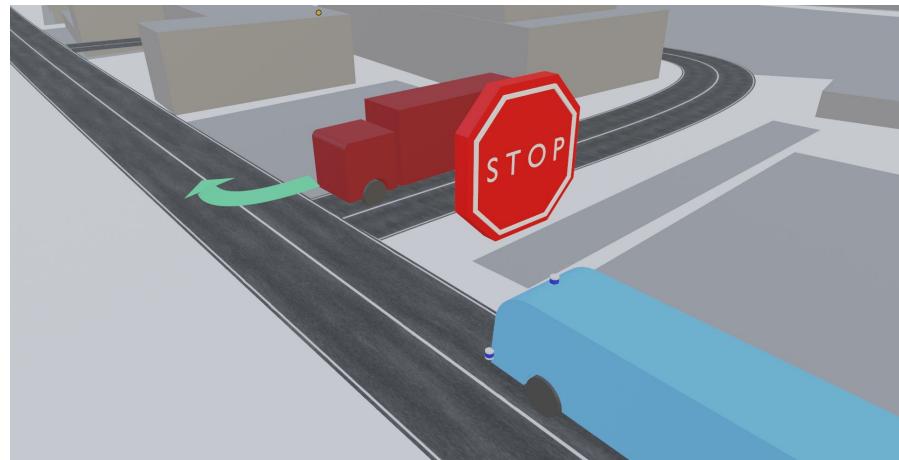
b. The system avoids the objects

3.6. Set service route via the HMI on the vehicle [UPDATED]

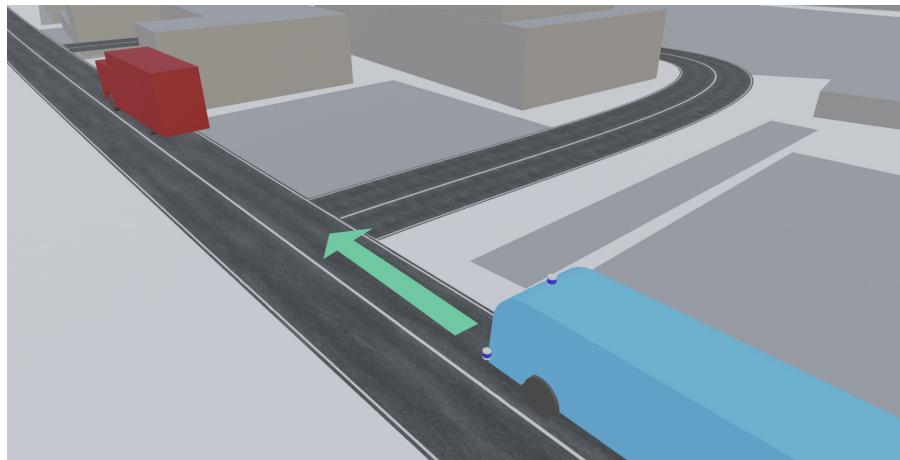
- The operator can set authorized service routes of the system via the Human Machine Interface (HMI) on the vehicle before the operation.
- The system can only accept a modified route while the vehicle is parked.
- **NOTE:** the service route cannot be changed without the authorization from the local government.

3.7. Interact with other vehicles on the public road

- The service route uses public roads, so the system interacts with other vehicles and must obey all traffic laws.
- When the vehicle approaches an intersection, the system is programmed to yield and take right of way with surrounding traffic, depending the actual situation and traffic laws.



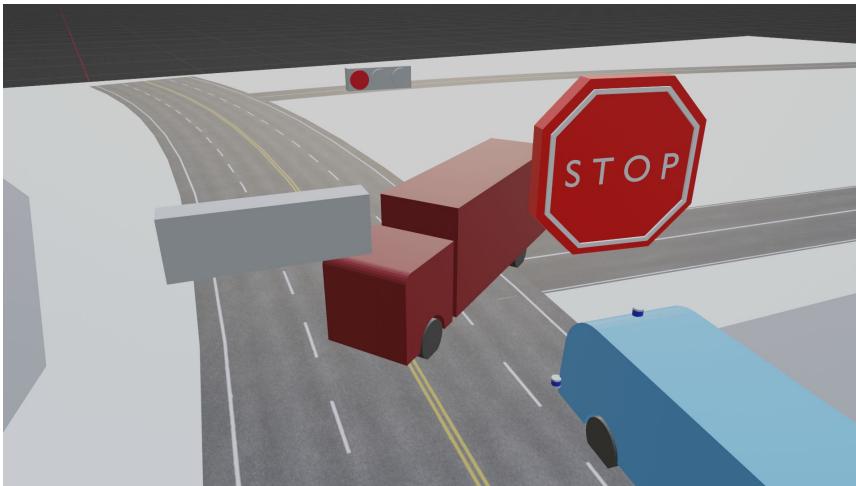
The vehicle automatically stops if another vehicle is entering the intersection.



The vehicle resumes operation after the other vehicle has cleared.

3.8. Interact with traffic lights

- When the vehicle meets a traffic light, the system performs one of the following actions:
 - Stop on a red light
 - Stop on a yellow light
 - Go straight, turn right, or turn left on a green light or arrow



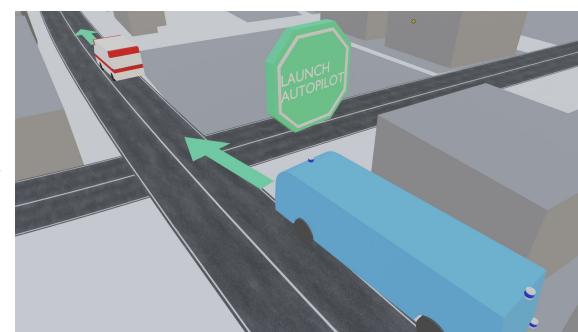
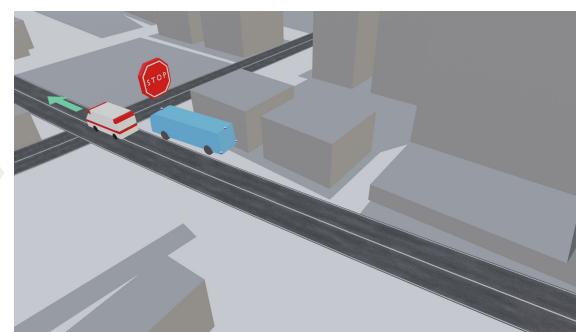
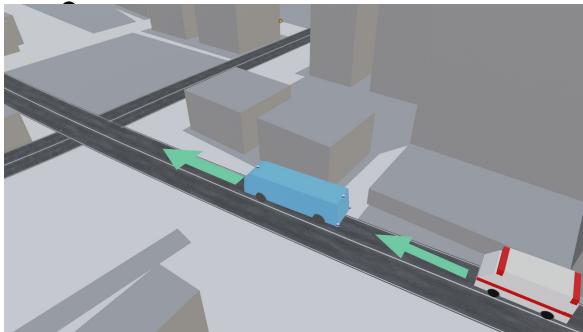
The vehicle stops on the red light



The vehicle moves on the green light

Interact with emergency vehicles

- When the vehicle meets an emergency vehicle, an in-car operator performs the following actions:
 - Promptly maneuvers the vehicle to the side of the road and stops
 - Manually re-launches the system after the emergency vehicle passes by
 - NOTE: The operator can use HMI (e.g., steering wheel or brake pedal) at any time to override the system control.

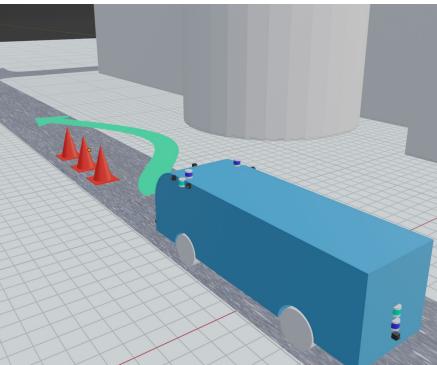
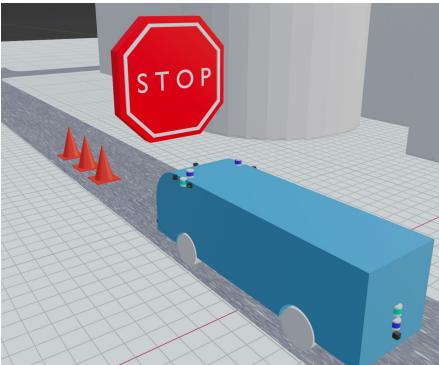


3.9. Operation Mode: Automatic/Manual [UPDATED]

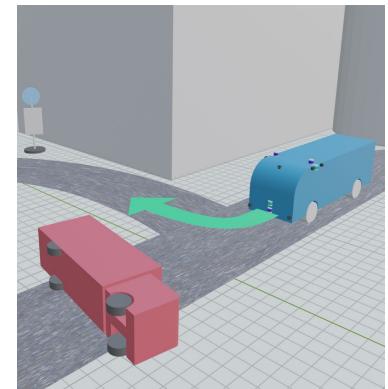
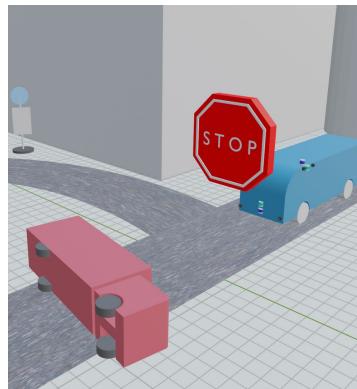
- The in-car operator manually launches the autonomous driving system, which causes the system to start the autonomous driving.
- If the fail safe system in the vehicle detects malfunctions or the in-car operator presses the button on the fail safe system, the system automatically changes the operation mode from automatic to manual. Then the vehicle automatically stops.

3.10. Take over request to the operator

- When the system cannot judge whether it can move forward, the system sends a recommendation to hand over operation to the in-car operator.
- The operator is supposed to perform the following actions when requested by the system:
 - Request to depart (refer to [3.4. Let passengers on and off at bus-stops](#))
 - Avoid objects
 - Detour



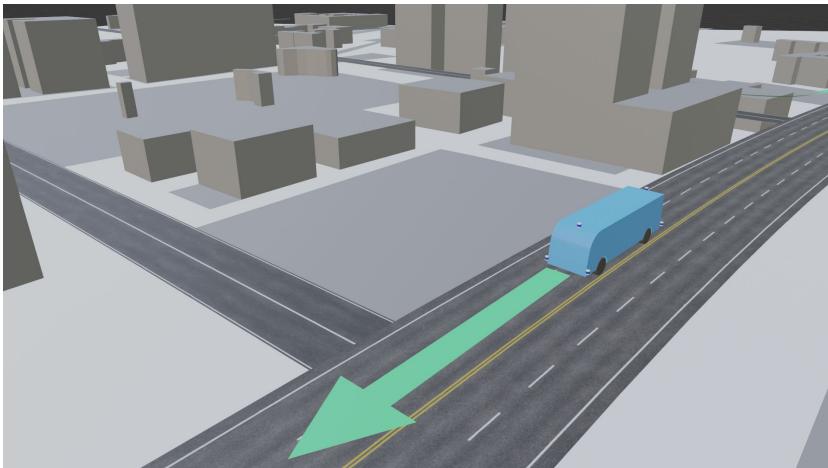
b. Avoid objects



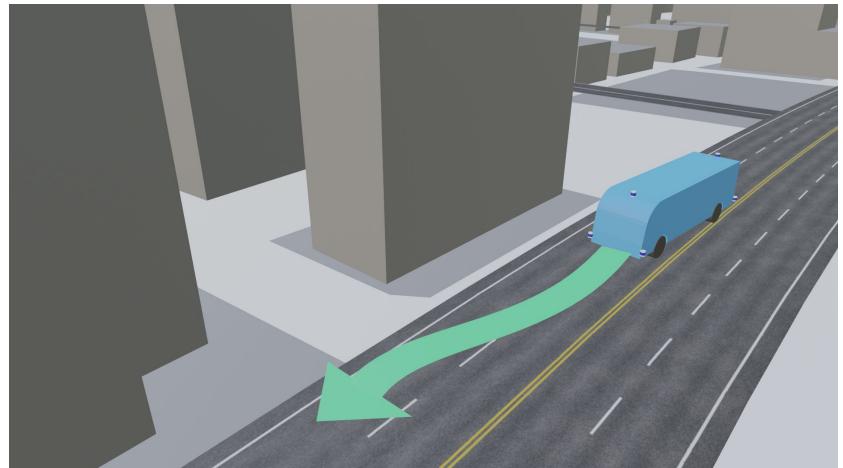
c. Detour

3.11. Lane keeping and Changing lanes

- The system stays the driving lane or changes lanes according to the route.



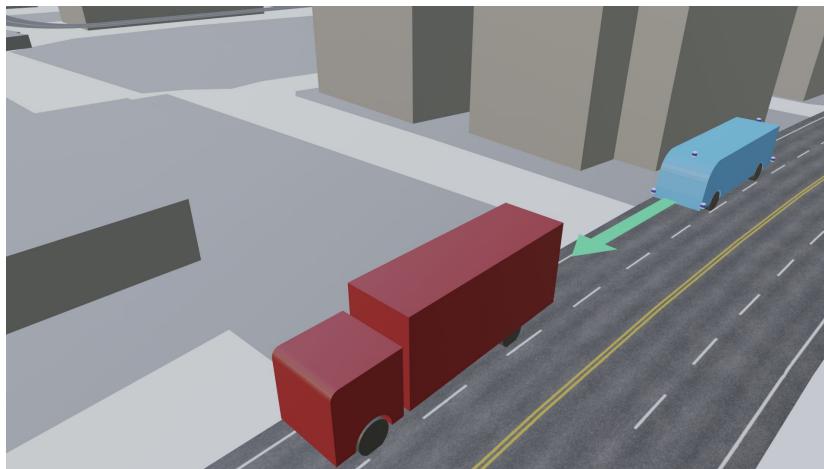
The vehicle maintains the driving lane



The system automatically changes the driving lane

3.12. Adaptive cruise control

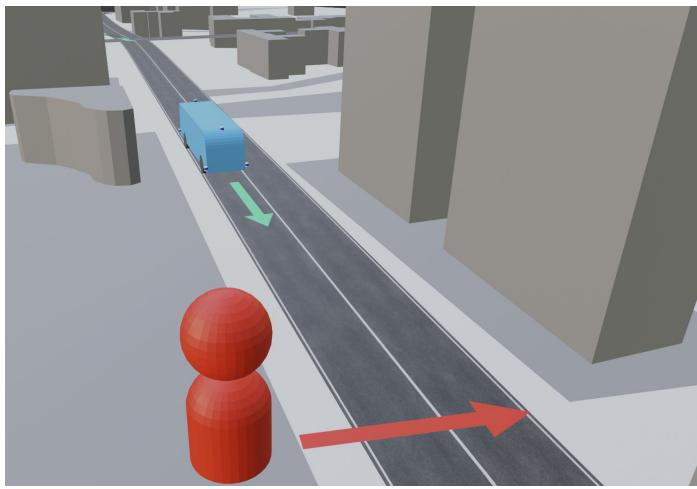
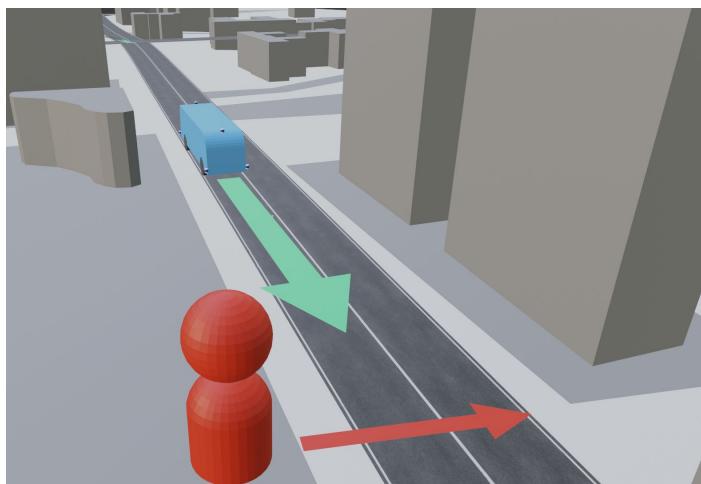
- The system automatically maintains a safe following distance and stays within the speed limit.



The system maintain the safety distance

3.13. Predict pedestrian stepping into the road

- The vehicle is programmed to detect pedestrians who may step into the road, and the vehicle decelerates in response.



The system detects a pedestrian who might step into the road, and decelerates.

4. OpsCons and correlated functions

- Functions are referred from ITRI's system-level Spec for HSR Field Trial

LN	OpsCons	Function
1	Daytime Operation [UPDATED]	source: "ITRI Autonomous Bus Pilot Run in Hsinchu Update"
2	Nighttime Operation [UPDATED]	source: "ITRI Autonomous Bus Pilot Run in Hsinchu Update"
3	Follow a route	Left/Right Turn Control
4	Let passengers on and off at bus-stops	Precision Docking Control
5	Avoid collisions	Emergency Brake Control, Obstacle Overtaking Control
6	Set service route via HMI on the vehicle [UPDATED]	
7	Interact with other vehicles on the public roads	Intersection Passing Control
8	Interact with traffic lights	Traffic Light Waiting Control
9	Operation Mode: Automatic/Manual	
10	Take over request to the operator [to be discussed]	
11	Lane keeping and changing lanes	Lane Keeping, Lane Changing Control
12	Adaptive cruise control	Cruise Control, Adaptive Cruise Control
13	Predict pedestrian running out into the road	Preventive Brake Control,

Appendix: What is ConOps and OpsCon?

- **Concept of Operations (ConOps):** "... the ConOps describes the overall high-level concept of how the system will be used to meet stakeholder expectations, usually in a time-sequenced manner...", source [NASA Systems Engineering Handbook](#)
 - In short, it describes how the system achieves the user's mission with a picture and short sentences.
- **Operational Concept (OpsCon):** "The operational concept is designed to give an overall picture of the operations using one or more specific systems, or set of related systems, in the organization's operational environment from the users' and operators' perspective.", source [SEBoK](#)
 - In short, it describes
 - How the system achieves the mission using unique features/events/interactions
 - Relationships between the system and other systems
- **Benefits:**
 - Stakeholders can understand the system from the early stages of development
 - In particular, developers who have different backgrounds or perspectives can gain the same understanding

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Thanks Again !