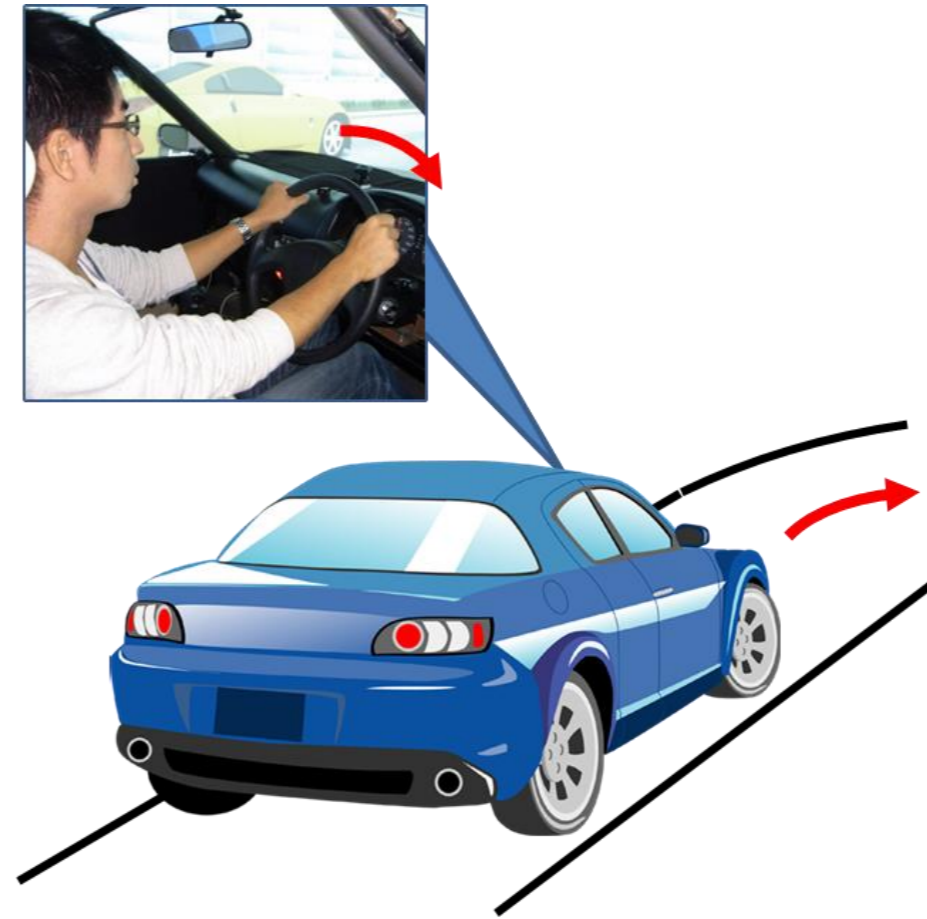# Haptic Guidance Control

Introduction

This is an assist system for a driver to realize smooth steering behavior by supplying tiny torque to the steering wheel to follow the desired trajectory. Its performance is examined through experiments using a driving simulator.
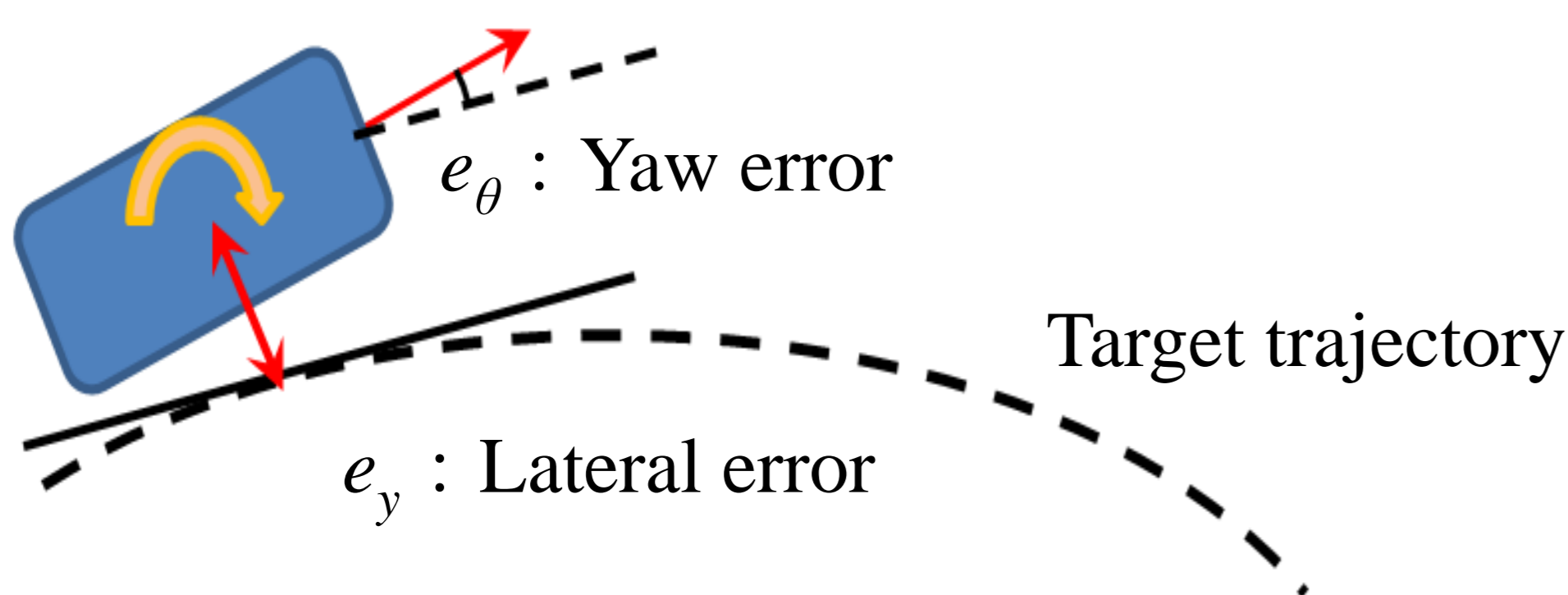
Movie of the haptic guidance

Haptic guidance controller

The haptic controller is designed to reduce the lateral error and the yaw error between the vehicle's position and the target trajectory. The assist torque u is obtained as

$$u = a_1 e_y + a_2 \dot{e}_y + a_3 e_\theta + a_4 \dot{e}_\theta .$$

e_θ : Yaw error

Target trajectory

e_y : Lateral error

Driving simulator, DS

The haptic guidance control is achieved on the driving simulator, where an electric power steering, eps, system is installed. The system simulates the assist torque in addition to reaction torque produced by a typical eps.

Improvement of steering behavior in right and left turns

The DS simulates the haptic guidance control in right and left turns in the experiment with 10 subjects. The deviations of the trajectories are reduced particularly when the additional task, PASAT, oral calculation task, is imposed on the subjects.
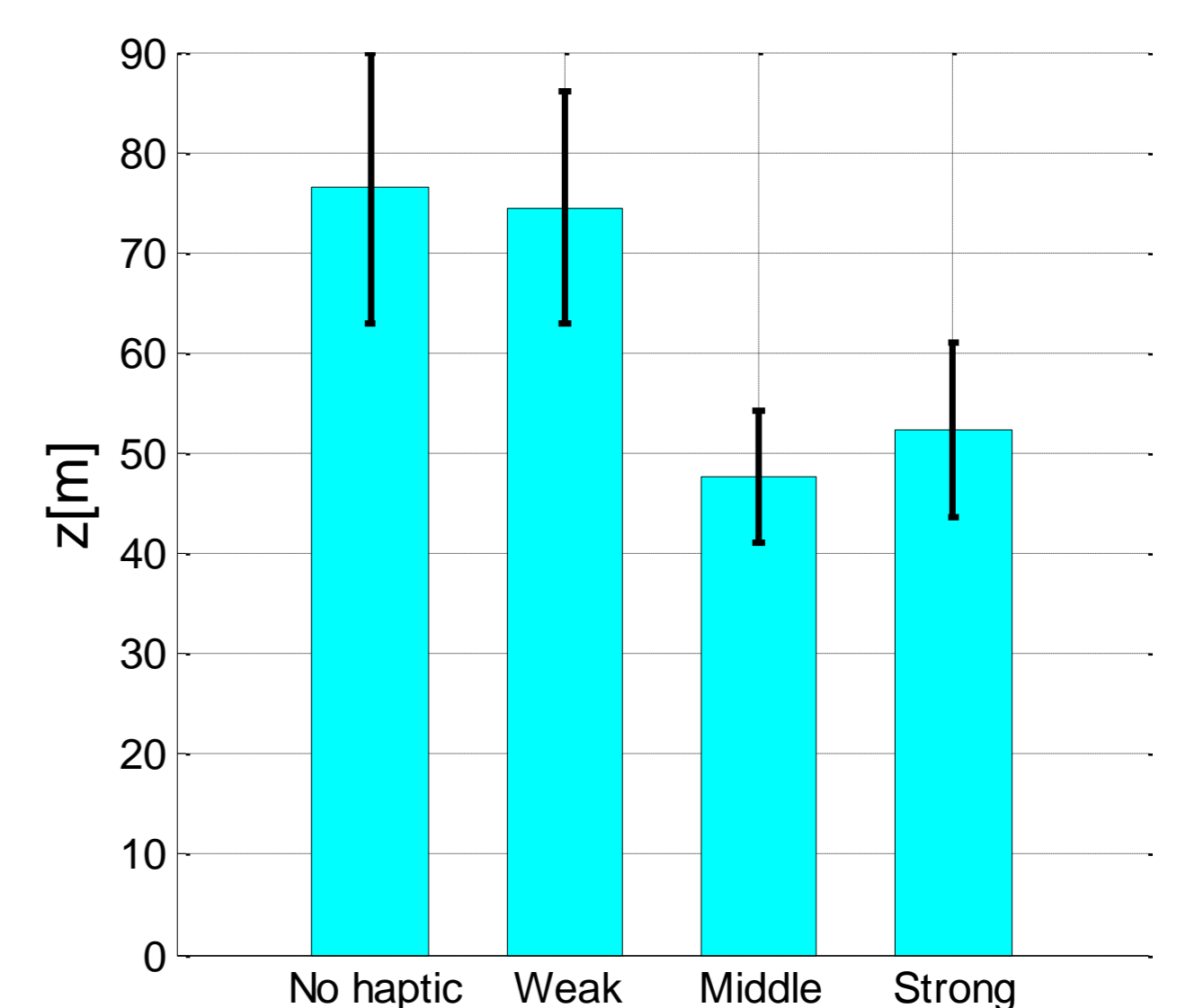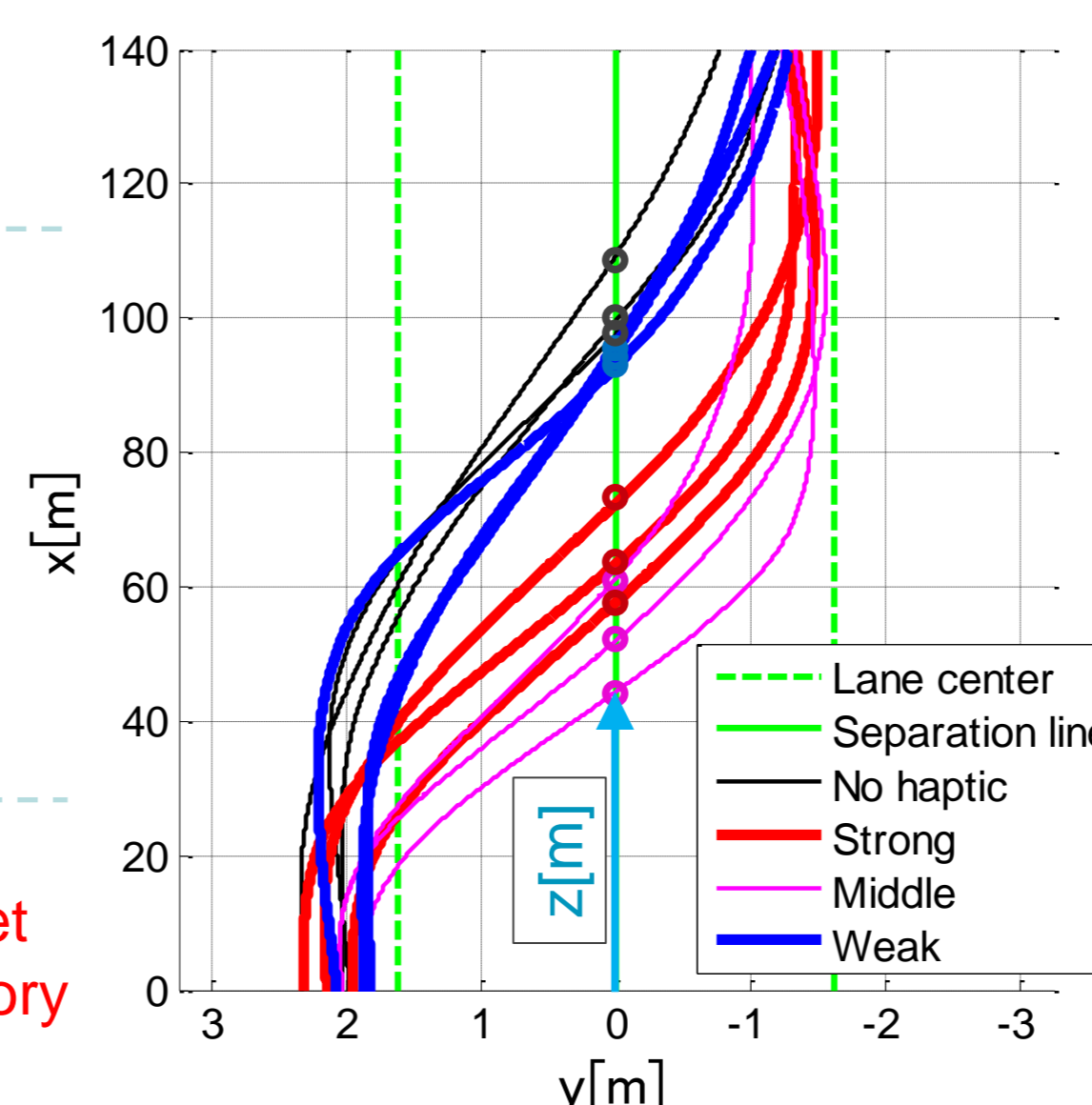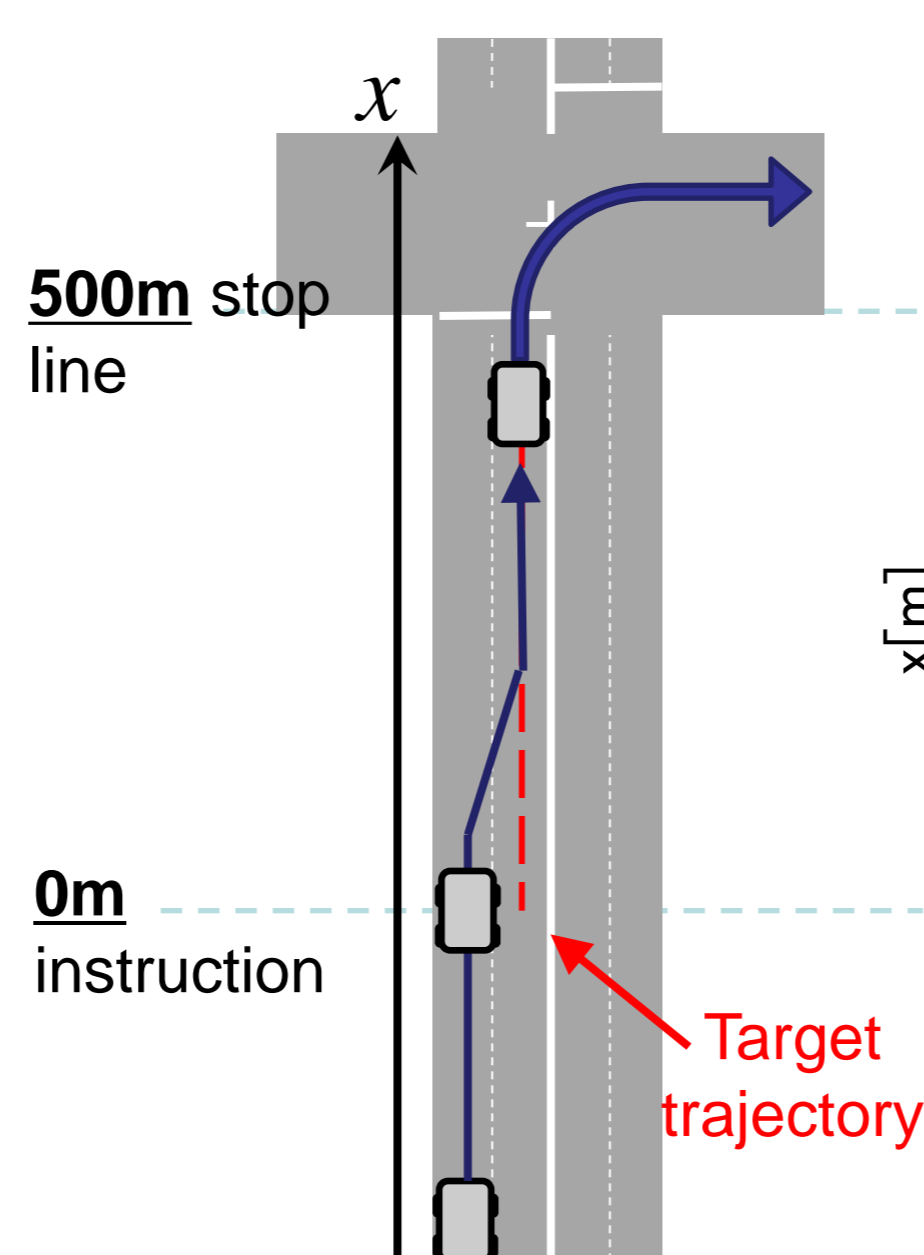
Virtual Center (x,y)

Normalized distance [deg]

deviation
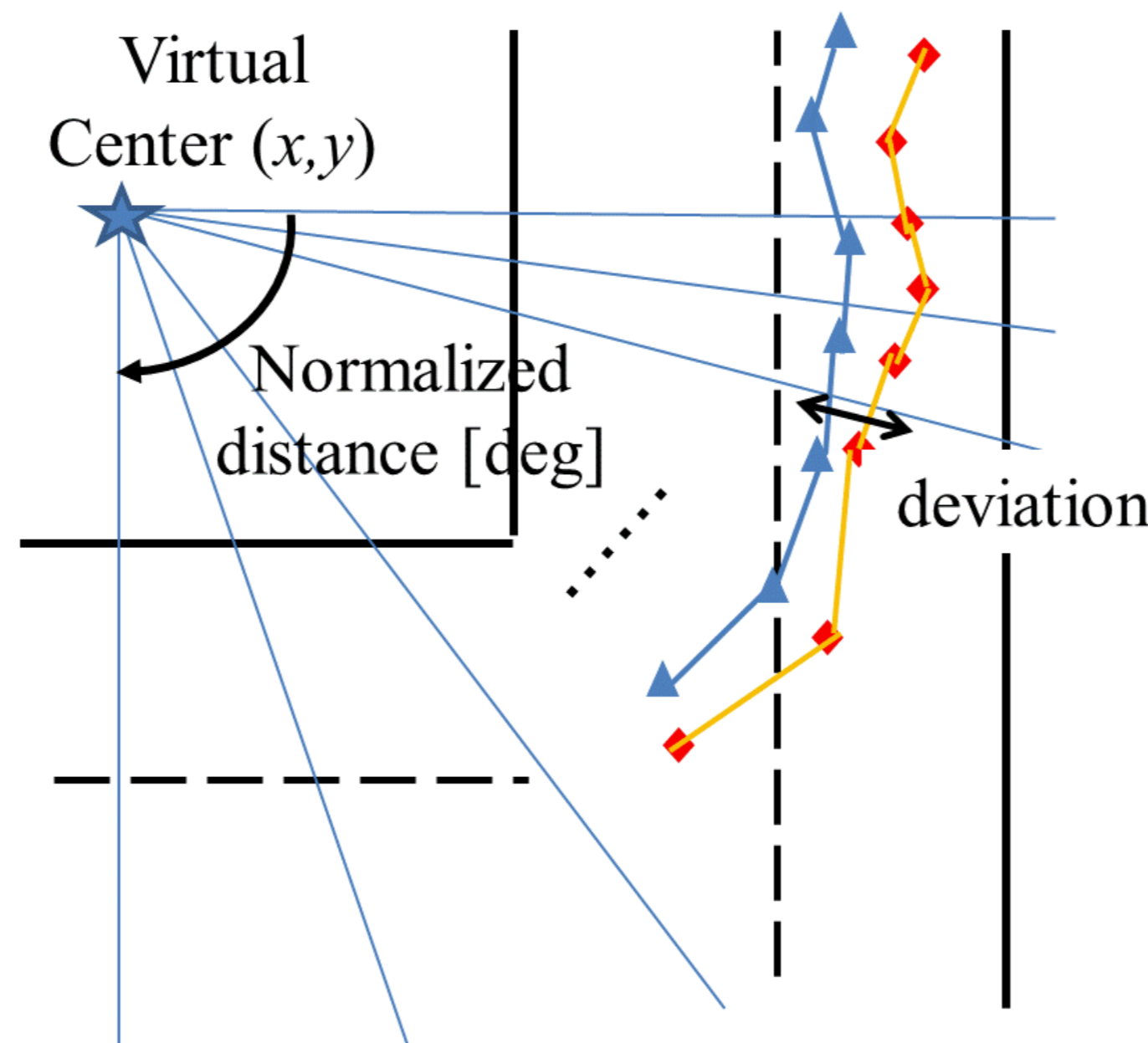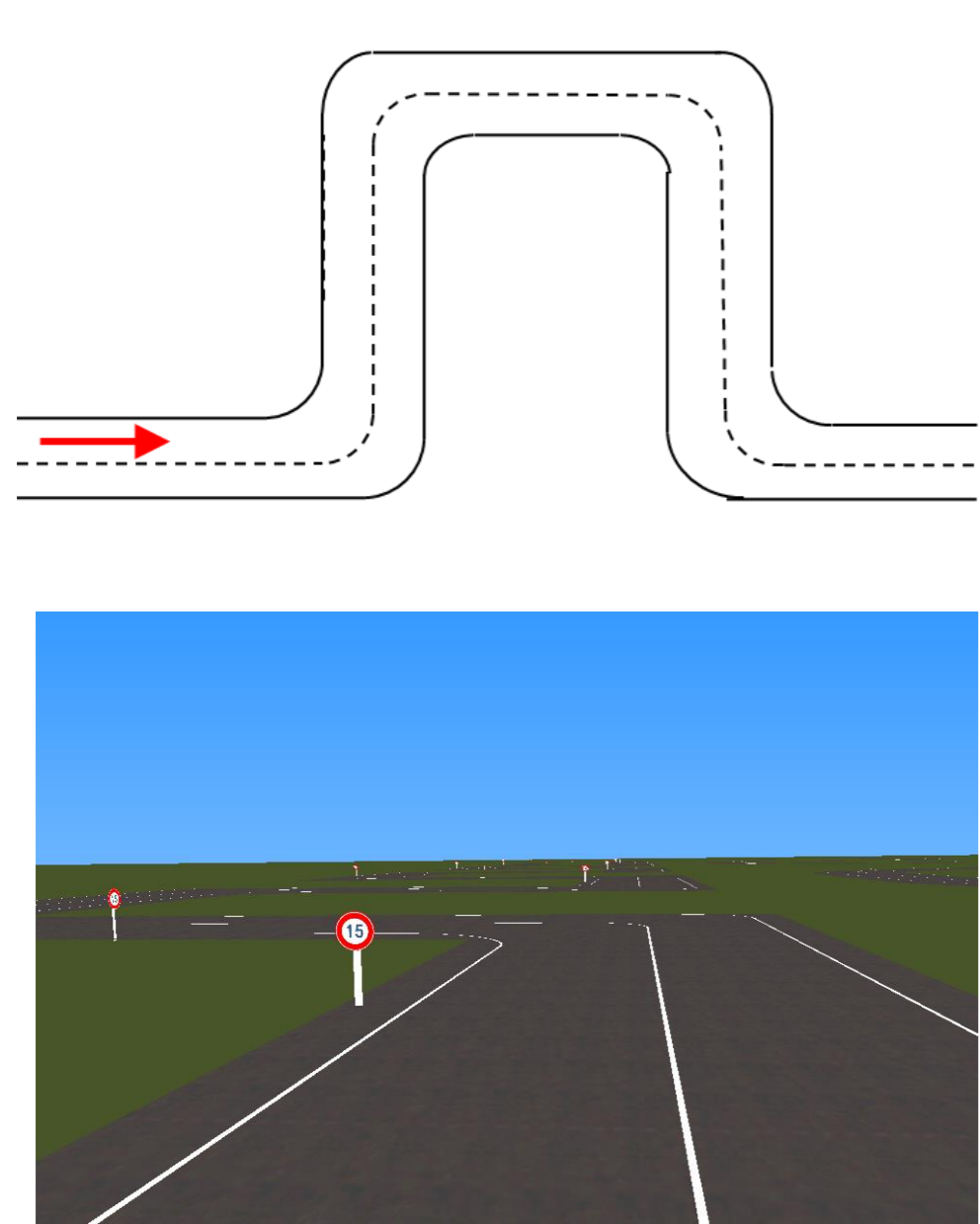
Subject No.	Left turn		Right turn	
	Normal	PASAT	Normal	PASAT
1	○	○	○	○
2	-	○	○	○
3	○	○	○	○
4	○	×	-	×
5	○	○	○	-
6	○	○	○	○
7	-	○	○	○
8	-	○	○	-
9	-	○	○	×
10	-	×	×	×

○ : Significantly($p<0.05$, t-test) improved by the Haptic control
× : Significantly($p<0.05$, t-test) deteriorated by the Haptic control
— : No significance

Application to lane change assist

The haptic guidance control can be used to navigate drivers. The experiments to induce the lane change with the assistant torque were carried out. Three types of torque, weak, middle, and strong are applied. The results show the drivers change the lanes more speedy when the assist torque is supplied and the larger assist toque is not always more effective.

x

500m stop line

0m instruction

Target trajectory

Lane center
Separation line
No haptic
Strong
Middle
Weak

z[m]

x[m]

y[m]

z[m]

No haptic Weak Middle Strong

Publications

Nakano K., Zheng R., Takahashi T., Ishihara A., Segawa M., 2015, Recognition Testing for Lane Change Assist by Haptic Guidance, Proceedings of 14th ITS Asia-Pacific Forum, 27-29 April, Nanjing China.

Takahashi T., Nakano K., Zheng R., Ohori M., Nakamura H., Segawa M., 2014, Trajectory Analysis by Haptic Steering Accompanying Audio Navigation, 12th International Symposium on Advanced Vehicle Control, 22-26 Sepbember, Tokyo, Japan.