Evaluation of Performance of Shared Control

Partner: JTEKT Corporation
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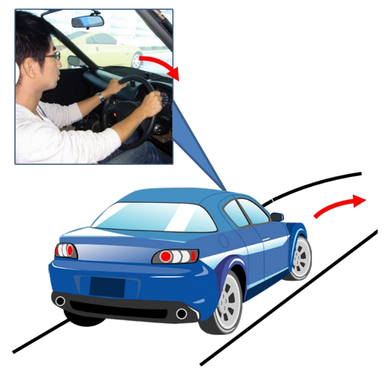
Introduction

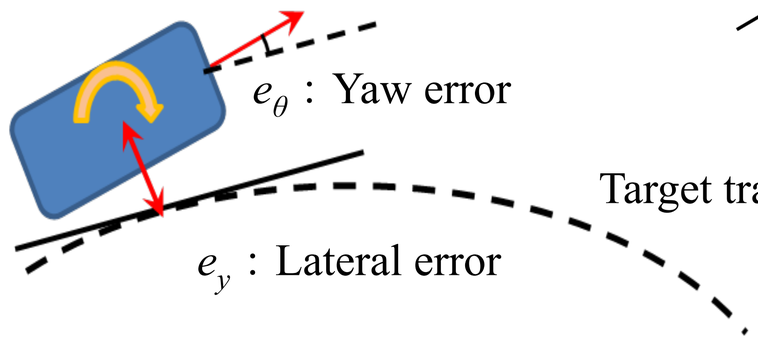
Shared control is a system controlling something cooperating with a human. A part of advanced driver assist systems of automobiles are corresponding to it. Our laboratory is conducting researches on a haptic steering guidance system as an example of the shared control.



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

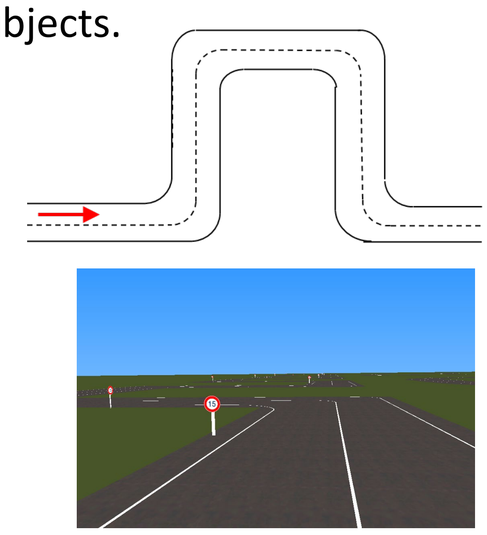
$$u = a_1 e_y + a_2 \dot{e}_y + a_3 e_\theta + a_4 \dot{e}_\theta \ .$$

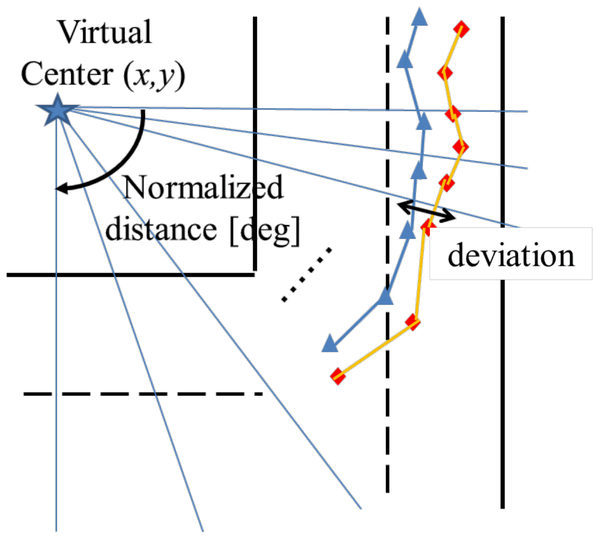


Movie of the haptic guidance

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.



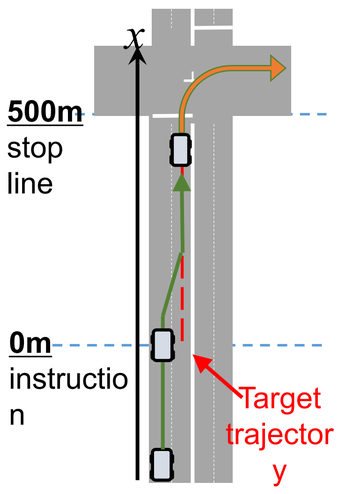


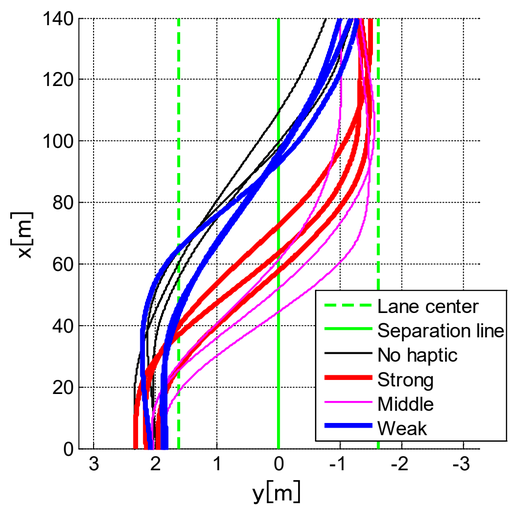
Subject No.	Left turn		Right turn	
	Normal	PASAT	Normal	PASAT
1	○	○	○	○
2	-	○	○	○
3	○	○	○	○
4	○	×	-	×
5	○	○	○	-
6	○	○	○	○
7	-	○	○	○
8	-	○	○	-
9	-	○	○	×
10	-	×	×	×

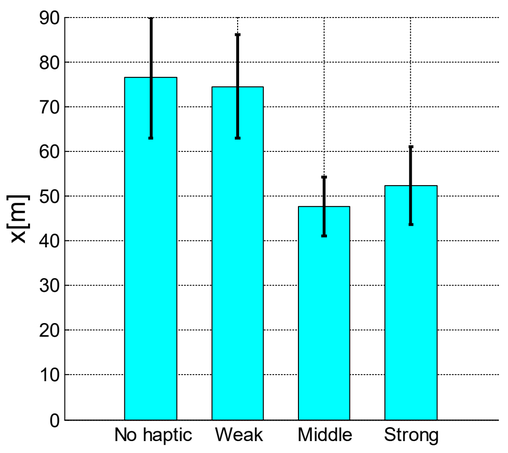
○ : Significantly($p<0.05$, t-test) improved by the Haptic control
× : Significantly($p<0.05$, t-test) deteriorated by the Haptic control
— : No significance

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.

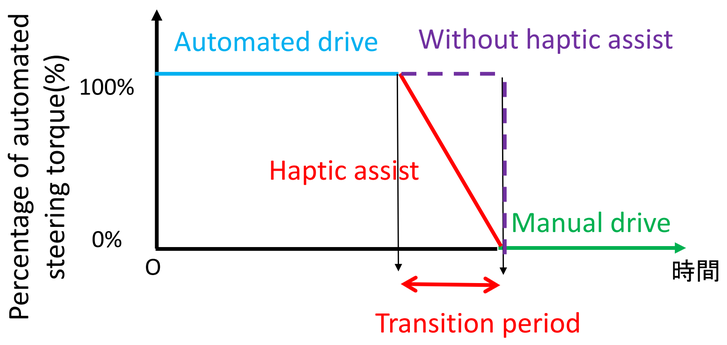




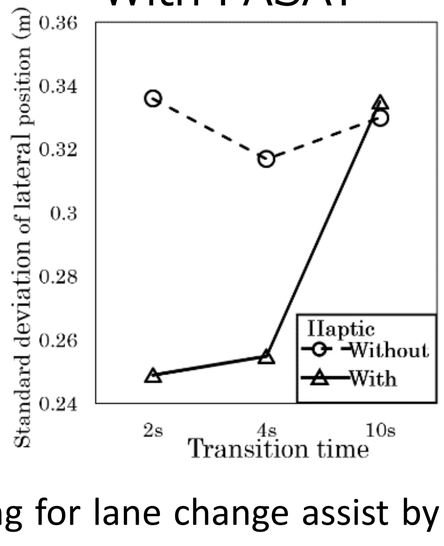


Assist in transition period

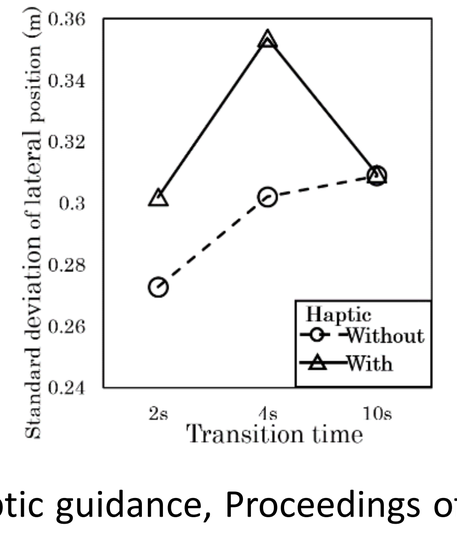
Haptic guidance can be used for driver assist in transition period from automated to manual driving. It is effective when the driver is distracted.



With PASAT



Without PASAT



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 September, Tokyo, Japan.

Nakano K.,, Chu X., Zheng R., Kaizuka T., Ishihara A., Hibi M., The effect of haptic guidance control on driving maneuver during time switching to manual from automated driving, JSAE Annual Congress (Autumn), October 2016, Sapporo, pp.489-492 (in Japanese).