

Development of Driver-Intention Estimation Using Gaze Behavior during Driving

- First Report -

Kenta Yamamoto¹, Teru Goto¹, Takashi Furuichi¹, Atsushi Tsubouchi¹

¹) Honda R&D Co., Ltd.

4630 Shimotakanezawa, Haga, Tochigi 321-3393, Japan

KEY WORDS: Human Engineering, Driver Model, Gaze Behavior, Intention Estimation, Driving Simulator [C2]

Human gaze precedes voluntary motor actions and reflects the planning process before movement execution. During driving, gaze shifts toward future path information before corresponding vehicle motion develops, suggesting that gaze contains information about the trajectory a driver intends to follow. Tuhkanen et al. reported that drivers predictively sample information along the future path and later showed that vehicle trajectories can be generated by a steering model using gaze position as a steering target. However, this model uses gaze as a steering input without explicitly considering the temporal lead of gaze relative to vehicle trajectory. This study therefore identifies gaze characteristics required for estimating an intended future path, focusing on the relationship between horizontal gaze angle and vehicle-path curvature and on the lead of gaze behavior during corner entry.

Experiments were conducted using a motion-based driving simulator with five in-house test drivers. The course consisted of straight sections, transition curves, and steady circular arcs with radii of 60, 120, and 180 m. Five target speeds of 40, 55, 70, 85, and 100 km/h were tested. Horizontal gaze direction was measured at 250 Hz using a non-contact eye-tracking system, while vehicle speed and vehicle-path curvature were obtained from the simulator. A gaze-to-curvature gain was calculated from mean gaze angle and path curvature during steady-state cornering. During turn-in, gaze lead time was estimated as the time shift that minimized the sum of squared residuals between the gain-corrected gaze signal and measured path curvature. Lead time was then converted into lead distance using vehicle speed.

The experimental results revealed two principal findings. First, the gaze-to-curvature gain increased with vehicle-path curvature. This indicates that a single fixed gain is insufficient for converting gaze angle into future path curvature and that the gain should instead be adjusted according to the driven curvature. This tendency is consistent with predictive gaze strategies in which drivers use road geometry and multiple locations along the future path rather than tracking a single fixed point.

Second, gaze behavior preceded changes in vehicle-path curvature during corner entry. Gaze lead time became shorter as vehicle speed increased, whereas the corresponding lead distance showed only a small dependence on speed. This difference suggests that anticipatory gaze may be organized with reference to the distance to the attended location rather than a fixed time interval. Lead distance may therefore provide a more consistent spatial parameter across vehicle-speed conditions for gaze-based driver-intention estimation.

Overall, this study identified two fundamental parameters for gaze-based driver-intention estimation: a curvature-dependent gaze-to-curvature gain and a spatial gaze lead distance that is less dependent on vehicle speed than gaze lead time. These parameters provide a quantitative basis for converting gaze behavior into future vehicle-path curvature. Future work will use the identified gain and lead distance to generate future trajectories from gaze and evaluate estimation accuracy against measured vehicle trajectories.

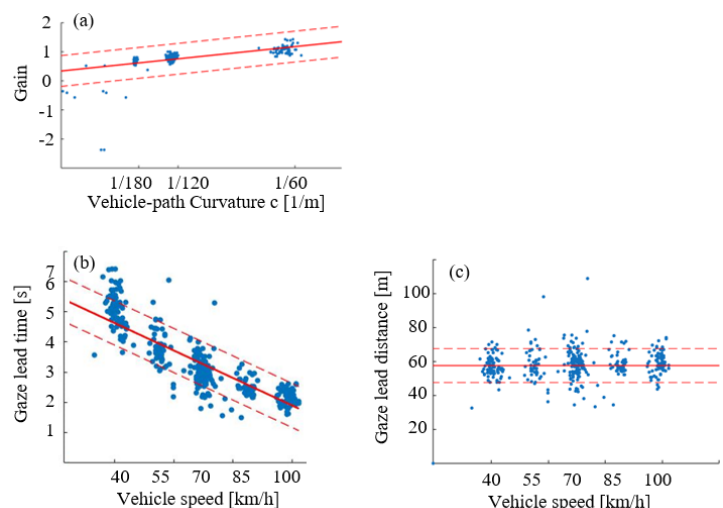


Fig. 1 Relationships between vehicle motion variables and gaze parameters (a) Gain and Curvature, (b) Gaze lead time and Vehicle speed, (c) Gaze lead distance and Vehicle speed