講演番号	182

文献番号	20225182

Estimation of Readiness for Automated Driving (First Report)

-Developing Estimation Model-

Yasuo Sakaguchi [1)] Yuji Muragishi [1)] Hiroshi Kuroyanagi [1)]

Tsutomu Tamura [2)] Yuki Nakahara [2)] Toru Ono [2)] Robert Fuchs [2)]

1) Toyota Central R&D Laboratories, Inc.
41-1 Yokomichi, Nagakute, Aichi 468-0001, Japan
2) JTEKT Corporation.
333 Toichi-cho, Kashihara, Nara, 634-8555, Japan

KEY WORDS: **human engineering, intelligent vehicle, cognitive reaction time,** distraction**,** driving ability [C2]

In level 3 autonomous driving, the driver is required to take over the driving within a certain time if necessary. Thus, it is important to monitor the driver's readiness for take-over and keep it a certain level. In this paper, we measure a time until the driver takes over when using the maximum ability that the driver can exert at that time. The time is quantified by defining it as an index corresponding to the readiness for take-over. The driver's readiness depends on how much cognitive, judgment, and operational resources are allocated to driving. Drivers get the information for driving from the visual sense mainly, it is considered that this resource can be estimated from the visual behavior.

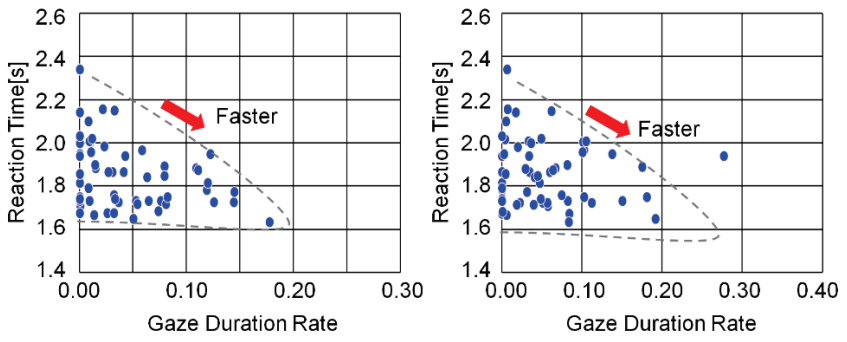
We performed experiments to measure drivers' reaction time after take-over request from autonomous drive during visual search subtask or auditory subtask using a driving simulator. In the experiment, drivers' gaze direction is also measured.

Then, by measuring relationship between gaze distribution and reaction time, we found that the less gaze time of rearview mirror and side mirror, the longer reaction time (Fig. 1). This relationship can be used to create a regression equation to estimate the takeover reaction time from the gaze distribution from 90s and 15s before takeover to takeover (Eq. 1).

$$T_R = -0.856V_{F1} - 3.184V_{M1} - 0.715V_{R1} - 0.826V_{L1} - 1.229V_{T1} + 0.305V_{F2} + 1.416V_{M2} - 0.702V_{R2} - 0.412V_{L2} + 0.651V_{T2} + 2.390 \quad (1)$$

T_R : Reaction time [s]
V_{F1} : Gaze duration rate to front view (time window:90s)
V_{M1} : Gaze duration rate to rearview mirror (time window:90s)
V_{R1} : Gaze duration rate to right side mirror (time window:90s)
V_{L1} : Gaze duration rate to left side mirror (time window:90s)
V_{T1} : Gaze duration rate to meter or task display (time window:90s)
V_{F2} : Gaze duration rate to front view (time window:15s)
V_{M2} : Gaze duration rate to rearview mirror (time window:15s)
V_{R2} : Gaze duration rate to right side mirror (time window:15s)
V_{L2} : Gaze duration rate to left side mirror (time window:15s)
V_{T2} : Gaze duration rate to meter or task display (time window:15s)

Fig.2 shows the relationship between the estimated and measured reaction times using this equation. The coefficient of determination is R^2=0.457. Therefore, we could develop the readiness estimation model from the driver's gaze behavor.



(a) Rearview Mirror (b) Left Side Mirror

Fig.1 Gaze Duration Rate vs Reacion Time

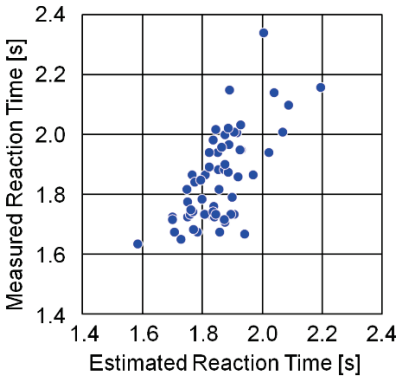


Fig.2 Estimation Result