A Study of Driver Status Estimation by Analyzing Deviation of Steering Angular Frequency

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Introduction
The driver distraction level of a voice-activated system is lower than that for a manually operated system because less posture change and glance-loss time are required in comparison with in-vehicle displays\(^1\)\(^,\)\(^2\). However, little is known about the effect on driver performance when alert sounds and a voice-activated system are used at the same time. Furthermore, there have been few studies on driver stimulus response times, especially for auditory stimuli.

Experiment Method
For measuring the auditory stimulus response time, a stimulus measurement system was installed in a driving simulator.

- Measurement data : Auditory stimuli response time, Steering angle
- Analysis data : Steering angle basic frequency with interpolation formula in FFT (Figure 1)
- Number of Participants : 10 (All participants had a valid driver license in Japan.)
- Driving task : Keep 80km/h on a straight road and maintains a safe distance for a lead vehicle.
- Subtask : A) Driving only
  B) Destination to my home
  C) Destination to nearby landmark
  D) Destination to address
  E) Search and set destination
- Subtask workload : [LOW] \( B < C \leq D < E \) [HIGH]

Results
Deviation of steering angle basic frequency is the highest correlation with the auditory stimulus reaction time. (Table 1 and Figure 5)

<table>
<thead>
<tr>
<th>Steaming Angle (average)</th>
<th>Steaming Angle (1σ)</th>
<th>Steaming Angle Basic Freq. (1σ)</th>
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<tbody>
<tr>
<td>-0.33</td>
<td>0.67</td>
<td>-0.93</td>
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Discussion
- This study indicated that deviation of steering angle basic frequency is suitable for auditory stimuli response time estimation.
- Further work is underway to clarify driver state estimation and indication method while the driver use voice-activated system.

Conclusion
The auditory response time is estimated from the basic frequency deviation of the steering angle with frequency interpolation formula.

References