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

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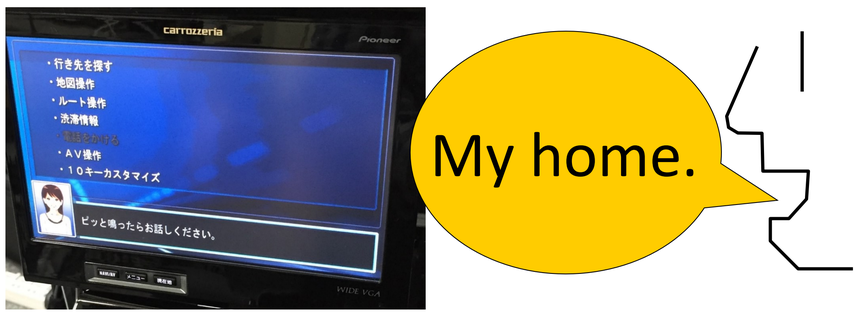
Introduction

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

  } Car Navigation system

  Smartphone (Google app)

  } Using voice-activated system
- Subtask workload : [LOW] B) < C) ≦ D) < E) [HIGH]

$$f_{peak} = m+\beta = m+ (3/ (1+r_m/r_{m+1})) - 1$$

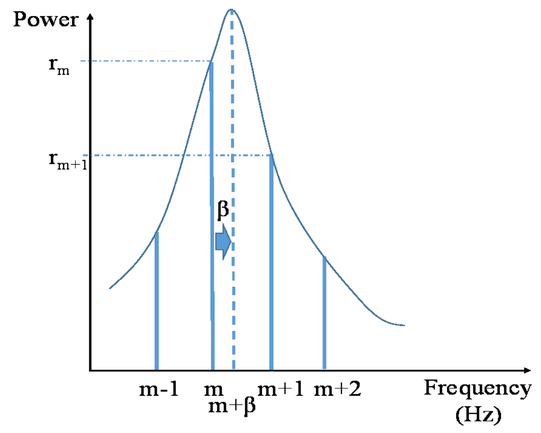


Fig.1 Interpolation of frequency[3)]

Results

Auditory stimuli response time is depending on voice-activation task

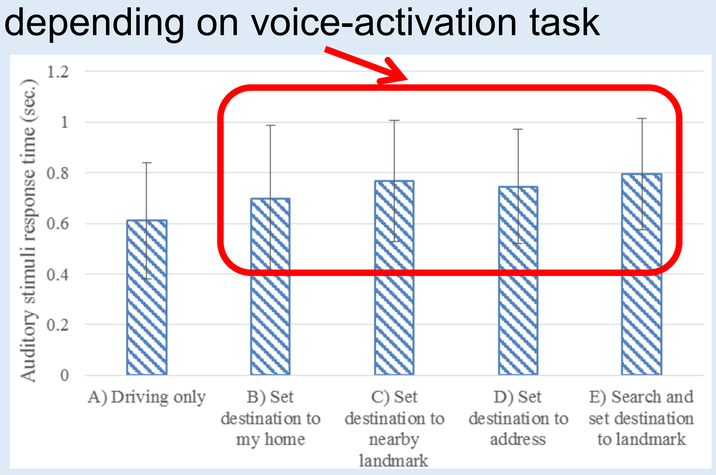


Fig.2 Auditory stimuli response time

Steering angle deviation on subtask E) is of particular note

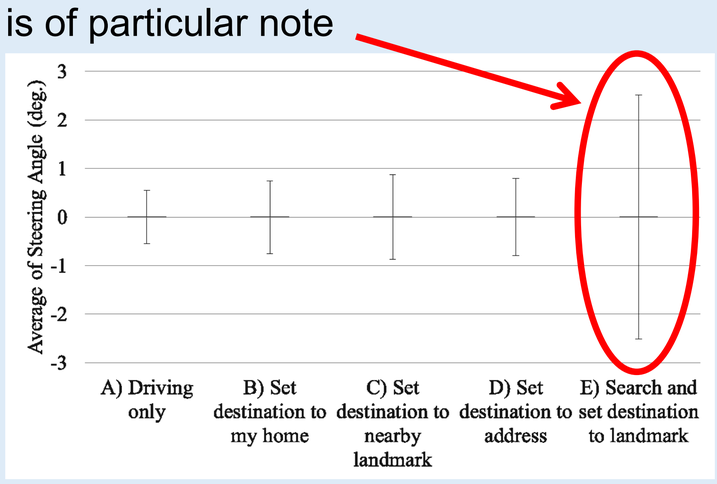


Fig.3 Average of steering angle

Deviation of steering angle basic frequency on subtask B),C),D),E) are less than driving only condition (subtask A)) .

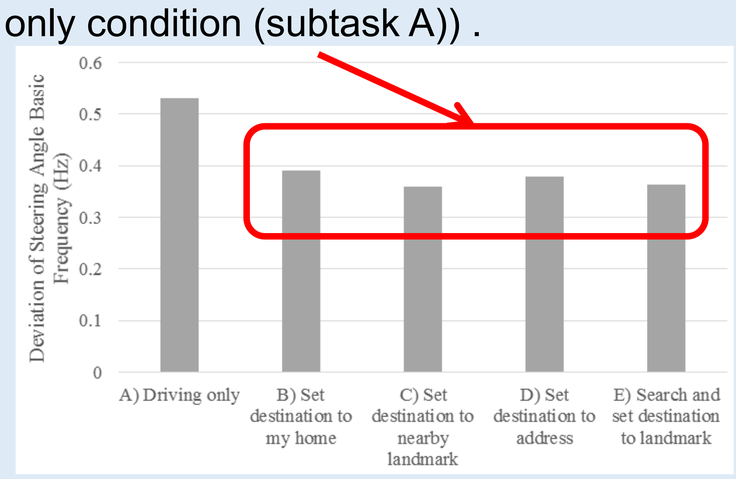


Fig.4 Deviation of steering angle basic frequency

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

Table 1 Correlation of steering angle parameters and auditory stimuli response time

Steering Angle (average)	Steering Angle (1σ)	Steering Angle Basic Freq. (1σ)
-0.33	0.67	-0.93

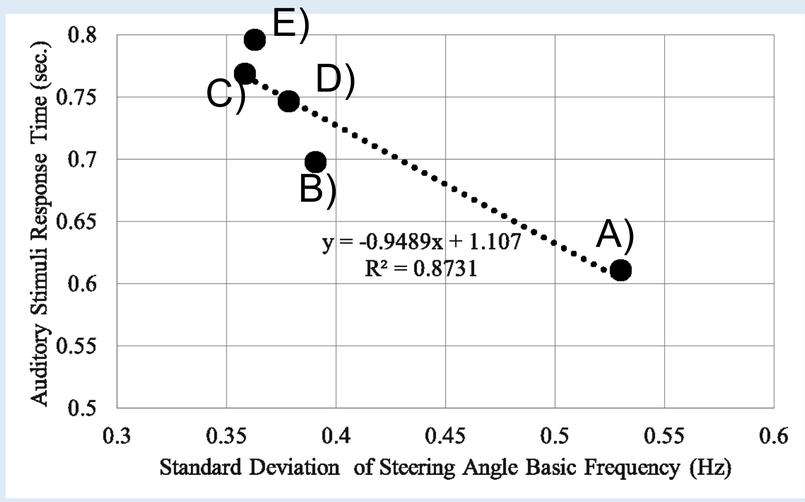


Fig.5 Relationship of steering angle basic frequency deviation and auditory stimuli response time

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

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