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Evaluation of driving skill and occupant status using human body motion and driving behavior indices

Akinari Hirao[1)]　Yoh Kato[1), 2)]　Toshihisa Sato[1)]

1) National Institute of Advanced Science and Technology (AIST)
AIST Central 6, Higashi 1-1-1, Tsukuba, Ibaraki, 305-8566, Japan (E-mail: akinari.hirao@aist,go,jp)
2) Sumitomo Riko Co., Ltd.
Higashi 3-1, Komaki, Aichi, 485-8550, Japan

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Driving skill is the one of important factor connected with relief feeling and comfort of vehicle occupants. The aim of this study is to evaluate driving skill using indices of passenger's body motion and driving behaviors. Experiments were done using courses made at AIST proving ground (Fig.1). Normal driving and quick driving condition by 1 veteran driver with participant sir in passenger seat. Following parameters were obtained with 30 participants (male 15, female 15); subjective evaluations (driving skill, comfort), driving behavior (vehicle speed, acceleration, pedal, and steering operation), body motion by Azure Kinect, seat pressure distribution (Sumitomo-riko SR softvision). Following indices were calculated.; skill index (vehicle longitudinal acceleration, speed jerk, lateral acceleration, steering jerk, steering entropy), body motion (thorax displacement, head displacement), seat pressure (total pressure, contact area, lateral center of gravity displacement).

Correlation between driving skill indices and "driving skill" evaluation is shown in Table.1. It shows longitudinal acceleration and speed jerk have strong correlation, but no correlation found for lateral direction. Correlation of body displacements were shown in Table 2. Body displacements have no correlation with "driving skill" evaluations (Table 2) due to stabilizing effect using muscles. On the other hand, seat pressure showed strong correlation with "driving skill" evaluations (Table 3).

Estimation formula was established by regression analysis as follows.

$$\begin{aligned}&Driving\ skill\ evaluation\\&=-4.464\times Leteral\ accelaration_{max}+6.274\times Leteral\ accelaration_{min}-2.276\times10^{-9}\times Speed\ jerk\\&-0.750\times Lateral\ CG\ displacement_{backrest}+0.034\times Lateral\ CG\ displacement_{seat}+3.720\end{aligned}$$

Using only seat pressure indices.

$$\begin{aligned}&Driving\ skill\ evaluation\\&=-4.464\times Leteral\ accelaration_{max}+6.274\times Leteral\ accelaration_{min}-2.276\times10^{-9}\times Speed\ jerk\\&-0.750\times Lateral\ CG\ displacement_{backrest}+0.034\times Lateral\ CG\ displacement_{seat}+3.720\end{aligned}$$

The results show seat pressure sensor can measure body movement that are now shown externally, and it is useful without vehicle sensor information.

Lane change "comfort" evaluation was also analyzed.

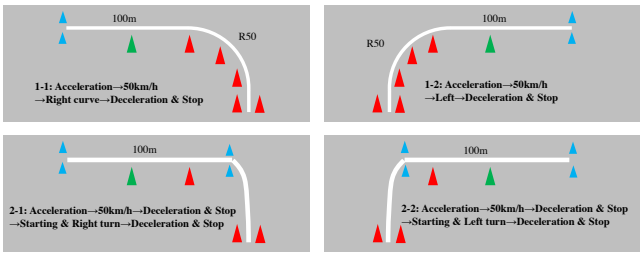

Fig.1 Curve course and driving conditions

Table 1 Correlation of skill indices

Direction	Skill index		Correlation coefficent	p-value
Fore-Aft	Longitudinal acceleration	Maximum	-0.707	<0.0001
		Minimum	0.682	<0.0001
	Speed Jerk	Maximum	-0.630	<0.0001
Right-Left	Lateral accelaration	Maximum (right)	-0.096	0.004
		Minimum (left)	0.133	<0.0001
	Steering jerk	Maximum	0.034	0.451
	Steering Entoropy		-0.154	0.0006

Table 2 Correlation of body displacement

Direction	Maximum lateral body displacement	Correlation coefficent	p-value
Fore-Aft	Thorax	-0.009	0.841
	Head	-0.122	0.009
Right-Left	Thorax	0.125	0.007
	Head	0.107	0.021

Table 3 Correlation of seat pressure

Direction	Pressure index		Correlation coefficent	p-value
Fore-Aft	Change of total pressure	Backrest	-0.435	<0.0001
	Change of contact area	Backrest	-0.440	<0.0001
Right-Left	Maximum CG lateral displacement	Backrest	-0.227	<0.0001
		Seat	-0.132	0.003