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Development of Evaluation Process for Vehicle Dynamics Performance on Considering Driving Characteristics of Customer Driving

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Developing an automatic evaluation HILS system for vehicle dynamics performance as drivability for both short-term development of vehicle dynamic performance and quality improvement. In the system, the vehicle speed profile design method uses a sigmoid function to prevent interruption of automatic evaluation due to unit or equipment failure or interlock by sudden operation, and to smoothly change vehicle speeds (Fig.1). However, since it is unclear whether the actual driving in the market can be properly simulated, it should be verified with actual operation data based on driving in the market.

Now, in order to extract the characteristics of drivers in the market, we used driving big data collected all around the world. Since it is conceivable that external factors such as the preceding vehicle may affect the driver's operation, we extracted the acceleration data while driving on a straight road without a preceding vehicle. In order to confirm driver characteristics, the extracted data was normalized to vechicle speed difference⊿V(from the starting vehicle speed to the final vehicle speed) and acceleration time ⊿t. As a result, as shown in Fig.2, vehicle speed profiles in the market can be roughly divided into two types: Aggressive line and Difensive line, that mean current vehicle speed profile design method is not sufficient.

For efficient and quality-assured evaluation, a function that can design the shape of aggressive line and defensive line and has fewer variables is required. Therefore, curve fitting is performed using a sigmoid function, a quartic function, a Fourier series, and a Gompertz function. Since Gompertz function were better in terms of fitting, and has fewer variables, it was judged to be more suitable to design function(Table1). Then, curve fitting to the market driving data using the Gompertz function yielded the distributions of b and c as shown in Fig.3. From this result, it is considered that the ranges of b and c can be limited for each driving pattern, and can determine the peak point to driving style : aggressive peak(i,k,m), defensive peak(j,l,n).

In order to confirm the effectiveness of the new design method, the evaluatin result of aggressive and defensive peak point was compared by perfomed evaluation HILS system. As shown in Fig4, Acceleration Load Decrease and Gear shift Coast/brake on upshift were found to deteriorate by one point or more during the aggressive line by the Gompertz function. This is because the longitudinal acceleration of the vehicle fluctuates significantly during gear shifting, and it was caused by acceleration control conducted by aggressive line. From the above studies, the effectiveness of the new desing method was confimed and Drivability evaluation process on considering driving characteristics in market was proposed.

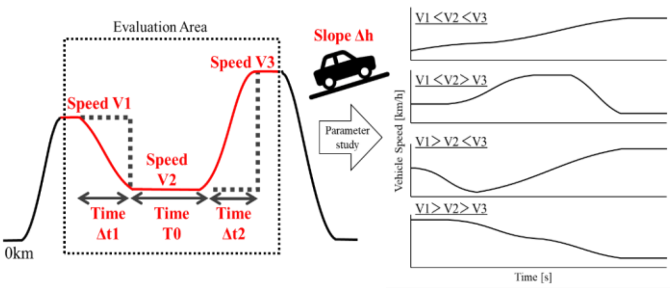

Fig.1 Vehicle speed profile

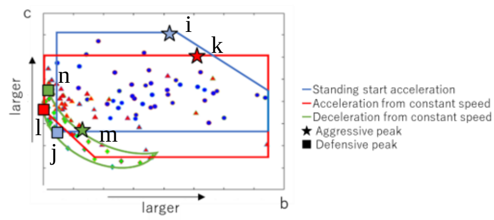

Fig.3 Distribution of variables in b and c

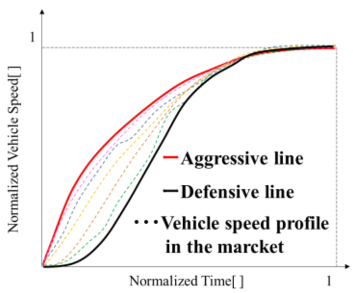

Fig.2 Classfication of Customer Driving

Table1 Requiremnts for function

	Defensive line	Aggressive line	Variable
Sigmoid	○	×	○ (2)
Quartic function	△	○	△ (5)
Fourier series	○	△	× (10)
Gompertz	○	○	○ (2)

$$f_{Gompertz} = \frac{\{b^{e^{-cx}} - b(1-x)\}}{b^{e^{-c}}}$$

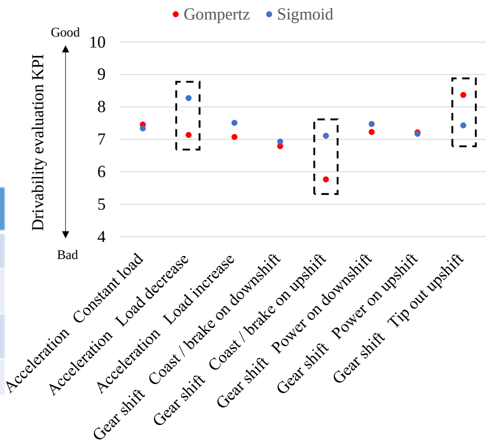

Fig.4 Results of grade about each KPI

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