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Extracting Ride Comfort Features of Vehicle Vibration by Hierarchical Clustering Method and Subjective Ride Comfort Evaluation

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Drivers are likely to feel comfortable with appropriate rolling or pitching which are originally unnecessary for driving as some researchers mention, although multiple suspension components and control methods to improve customer satisfaction aim to decrease vehicle body movement. With respect to ride comfort, it is often said that each car has a different “flavor” and it is preference characteristic. It may be also indicated that drivers feel comfortable with a part of vibration for ride comfort. However, it has not been comprehended enough what this feeling consists of. This article proposes a method to extract features of vibration that correspond to the characteristics of ride comfort by categorizing data measured in an actual vehicle using hierarchical clustering method. Figure 3 shows the idea of hierarchical clustering and hierarchical data clusters are obtained as shown in Fig. 4 by the method.

At the beginning, the data analyzed by this method is measured in actual vehicle while tuning suspension in a vehicle development process and labeled with positive and negative based on subjective evaluation by a test driver. As can be seen in Fig. 5-(a), it seems to be difficult to extract vibration features from the measured data. Second, the measured data is segmentalized with Fast Fourier Transform (FFT). Several segmentalized FFT data are obtained from a time series data by giving FFT length and overlap length to the method as parameters. Third, 1/3 octave band analysis is adapted to the segmentalized data for dimension reduction in order to improve hierarchical clustering. Finally, hierarchical clustering is adapted to the dimension reduced data and numerous clusters are given. As shown in Fig. 5-(b), the several clusters which has numerous lines similar to others are extracted from all clusters by using some indexes such as minimal variance on each of dimensions in the segmentalized data. Figure 5-(c) shows extracted gravities from Fig. 5-(b) to simplified and to obtain more understandable features. Figure 5-(c) implies that the test driver feels more comfortable to decrease body movement with 1-2 Hz than other frequency range.

Fig. 1 Example of a target vehicle

Fig. 2 Road for data measurement

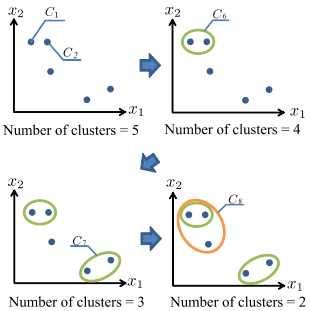


Fig. 3 Hierarchical clustering idea

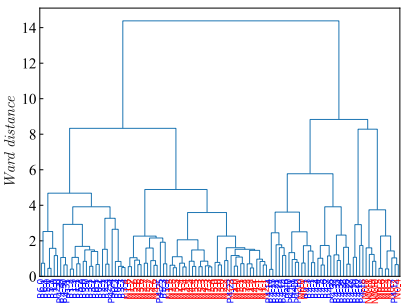
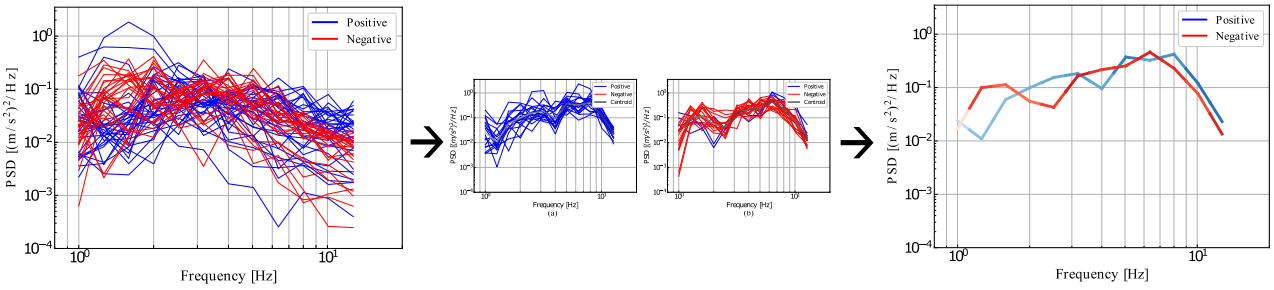


Fig. 4 Dendrogram



(a) (b) (c)

Fig. 5 Flow of extracting vibration features