Research of the correlation between the number of training data and machine learning prediction accuracy in vehicle crash analysis

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In an analysis of vehicle crash with a strong non-linearity, the prediction accuracy of machine learning (ML) using finite element method (FEM) analysis data seemly depends on the number of training data. The purpose of this paper is investigation about the correlation between the number of training data and the prediction accuracy of ML. The small overlap frontal crash analysis using the parametric vehicle model with fracture of body structure was conducted (Fig.1). The combination of 16 design parameters was generated by the Latin Hypercube sampling method (Table 1). 11,000 crash analyses were conducted, and ML models were built by randomly sampled training data from FEM results. The correlation between FEM results and ML results in a body deformation was confirmed, the ML result using 10,000 training data shows good accuracy compared with the ML result using 100 training data (Fig.2 and 3, the horizontal and vertical axes indicate the normalized value). Self-Organizing Maps (SOM) were created to visualize the non-linearity response by using 11,000 cases FEM results and ML results using 100 and 10,000 of training data (Fig.4). Maximum deformation of Footrest was observed at the red color cell A in the SOM based on ML results using 10,000 training data. In contrast, Footrest level over 0.6 cells were not observed in the SOM based on ML results using 100 training data. The trade-off curve between the number of training data and ML prediction accuracy of Footrest deformation at cell A was obtained (Fig.5).

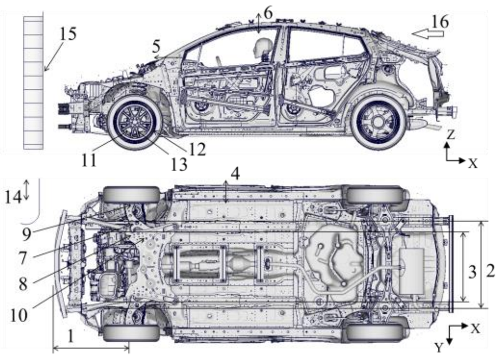

Fig.1 Design parameters

Table 1 List of design parameters and ranges

No.	Parameter
1	Length of front overhang
2	Width between front side members
3	Width of powertrain unit
4	Width of rocker
5	Front pillar upper end position
6	Roof height
7	Thickness of Lower arm
8	Fracture load on the suspension member side of the lower arm
9	Fracture load on the knuckle side of the lower arm
10	Fracture load of tie rod
11	Fracture strain of knuckle
12	Fracture strain of wheel rim
13	Initial angle of tire wheel
14	SOL barrier position
15	Friction coefficient between SOL barrier and vehicle
16	Initial velocity

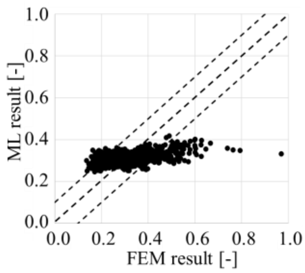

Fig.2 Validation of ML results of Footrest using 100 training data

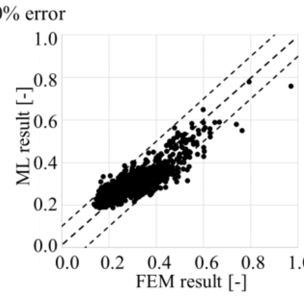

Fig.3 Validation of ML results of Footrest using 10,000 training data

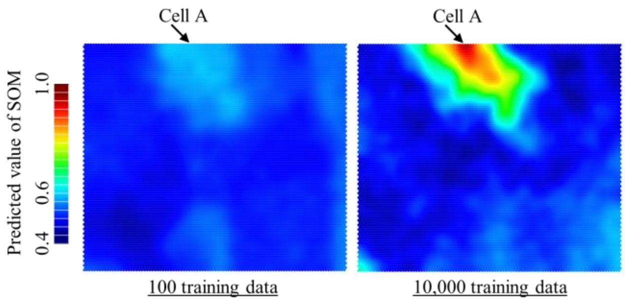

Fig.4 Self-Organizing Map of Footrest

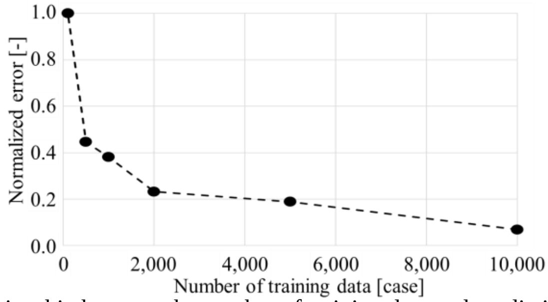

Fig.5 Relationship between the number of training data and prediction accuracy