講演番号	089

Proposal and feasibility study of new combustion analysis method based on heat release rate prediction using machine learning

Shojun Rachi [1)] **Kaname Naganuma** [1)]

1) Kanazawa Institute of Technology Graduate School
7-1 Ohgigaoka, Nonoichi, Ishikawa, 921-8815, Japan

KEY WORDS: **Heat engine, Spark ignition engine, Combustion analysis,** Theory/Modeling, Machine Learning (A1)

In recent years, internal combustion engines have been required to simultaneously achieve low emissions and high thermal efficiency amid increasingly stringent environmental regulations, while reducing development time and cost. Recent advances in machine learning, combined with the accumulation of large-scale experimental datasets, have enabled the development of novel prediction methodologies.

Against this background, the present study builds upon the new combustion analysis methodologies proposed by Dr. Chikahisa. and proposes a novel methodology for predicting in-cylinder pressure and engine performance. The proposed methodology comprises three concepts: Concept 1 performance prediction based on statistical methods using experimental data, Concept 2 performance prediction through Machine Learning and Physics-Based Model Integration, and Concept 3 model construction based on feature extraction and correlation identification by means of artificial intelligence.

The results demonstrate that Concept 1 achieves satisfactory prediction accuracy even with limited training data and retains reasonable accuracy under unseen conditions. For Concept 2, prediction accuracy is highly dependent on the target performance metric: high accuracy is attained for Gross Indicated Work (GIW) under interpolation conditions, whereas sufficient accuracy is not achieved for Combustion Noise Level (CNL). Furthermore, prediction accuracy is highly dependent on the accuracy of the heat release rate model used for in-cylinder pressure prediction. These findings suggest that improving prediction accuracy necessitates the appropriate selection and combination of models depending on the target performance metric.

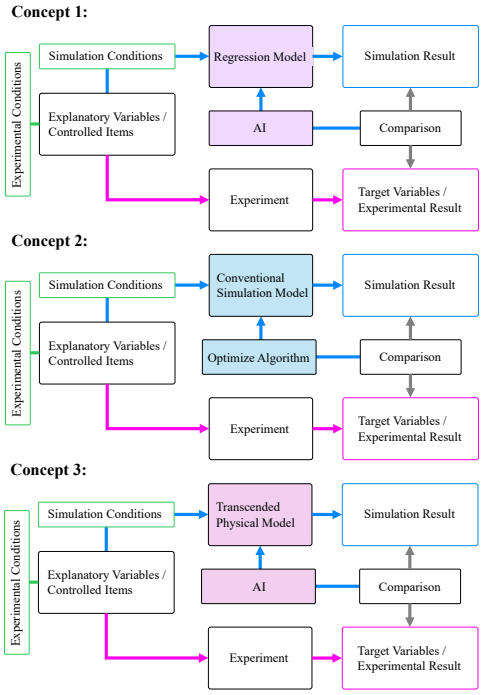

Fig.1 Three types of concepts in the new combustion analysis method using AI

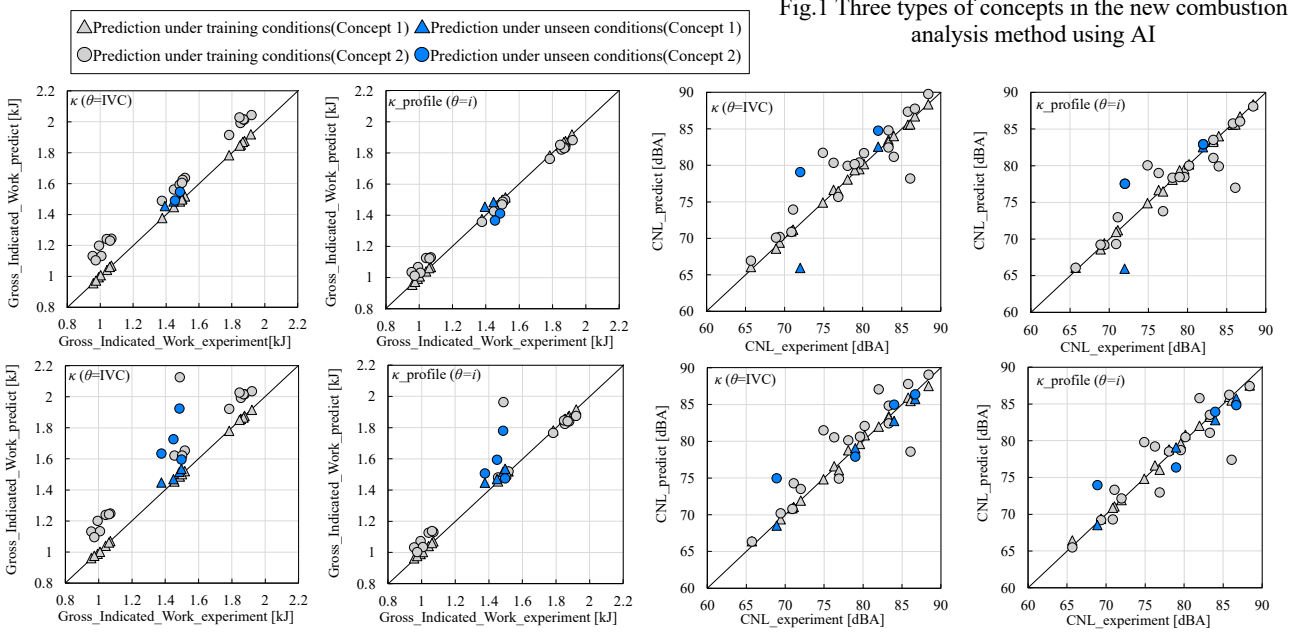

Fig.2 Correspondence analysis for GIW and CNL between experimental and predicted results under INTERPOLATION and EXTRAPOLATION conditions