Similar part identification integrating machine learning approaches with a SDM workflow

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1 Summary

Machine learning approaches for geometric part recognition have been evaluated with 3D automotive data [1], obtaining a near-perfect accuracy performance to find the exact part (one-to-one match) and with a small data proportion (one vehicle). However, engineers are also looking for plausibility for similar geometric matches to be implemented in a productive assembly line, obtaining not necessarily the same part but all similar shapes.

By doing so, we enhance the CAE process for advanced vehicle development in the early stages, using machine learning in the design analysis for the process of Carry Over Part (COP), comparing the information from unlabeled vehicle developments (automobiles from other OEM companies) and filtering similar design (or production facilities, specifications, etc.) to assist the automotive manufacturing process (see Fig. 1).

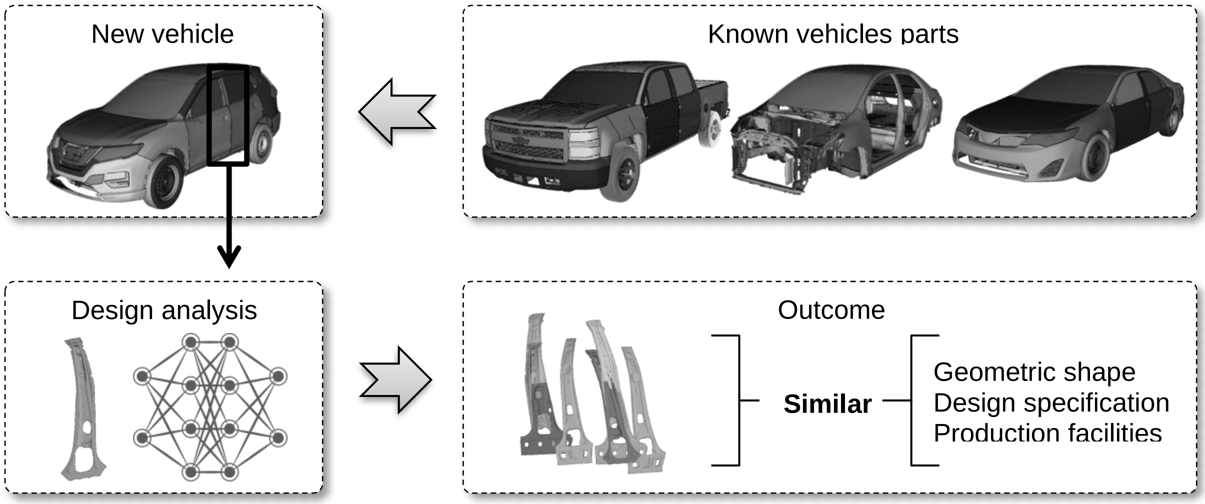

Fig.1: Research's motivation and objective (Vehicles are courtesy of the CCSA team [2]).

This work integrates a machine learning workflow with HPC resources and automotive CAD data using SCALE.model [3], a powerful data management system solution for large CAE databases. Herewith, we investigate the feasibility of different techniques in 3 main sections. The first section is the input preparation, which starts with a 3D point cloud transformation and includes data augmentation. Some approaches were investigated, which led to the iterative closest points (ICP) algorithm [4], which aligns all point clouds similarly and generalizes the model.

The second section is architecture customization, which involves adjusting the machine learning algorithm [5] for the specific use-case. The third section is the training customization, modifying the process with a proposed loss function exploiting the geometric similarities [6] between automotive parts, with a non-supervised class clustering and smooth labeling (see Fig. 2).

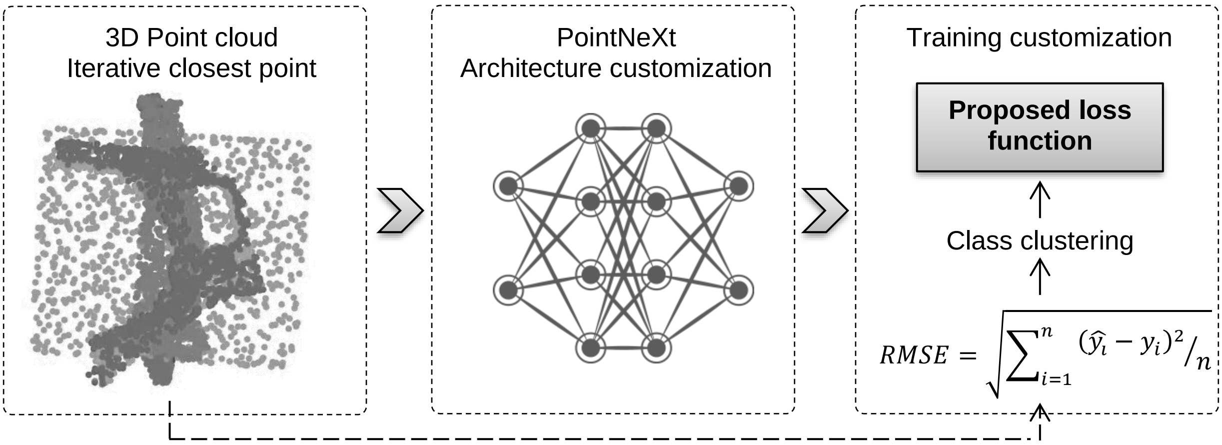

Fig.2: Machine learning workflow to find similar parts.

Findings indicate a more plausible model with a clear increase of similar parts in the top 20 predictions even for new and previously unreported automotive data (see Fig. 3), using the accuracy value ($Accuracy[\%] = \frac{\#\,Similar\ parts\ in\ top\ 20}{\#\,Similar\ parts} \times 100\%$) for comparison purposes. Such improvements within the scope of the research will strengthen the relationship between artificial intelligence and the automotive construction industry.

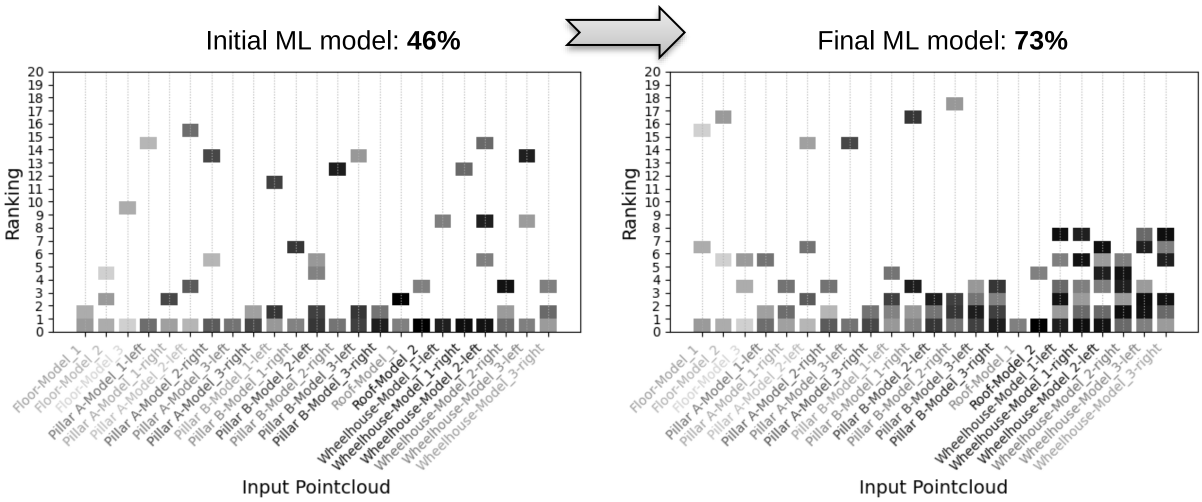

Fig.3: Initial and final state from a machine learning model within the scope of the research.

KEYWORDS: machine learning, SDM, similar parts, point cloud, iterative closest point, pointnext.

2 Literature

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