HFA-Transformer: Hierarchical Feature Aggregation based Transformer for Robust Point Cloud Registration

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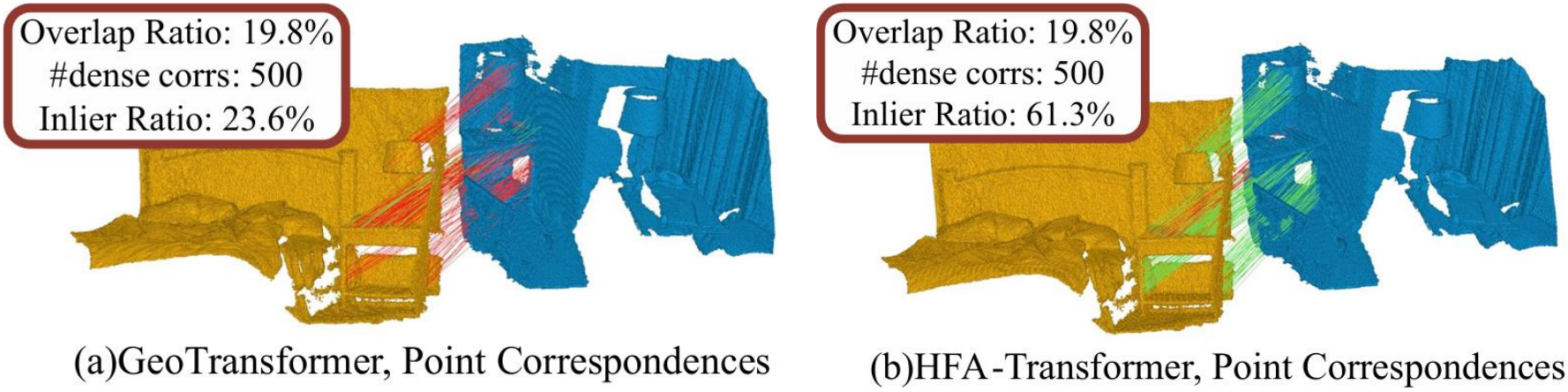
Problems & Ideas

- Problems of existing point cloud registration methods :
  - Insufficient modeling of global geometric structures leads to low-quality coarse features and unreliable initial correspondences.
  - Reliance on single-level features causes irreversible loss of fine-grained details, especially in challenging low-overlap scenarios.
  - Ideas: A hierarchical registration framework that achieves robust correspondence matching by enriching global feature representation and fusing multi-level features.



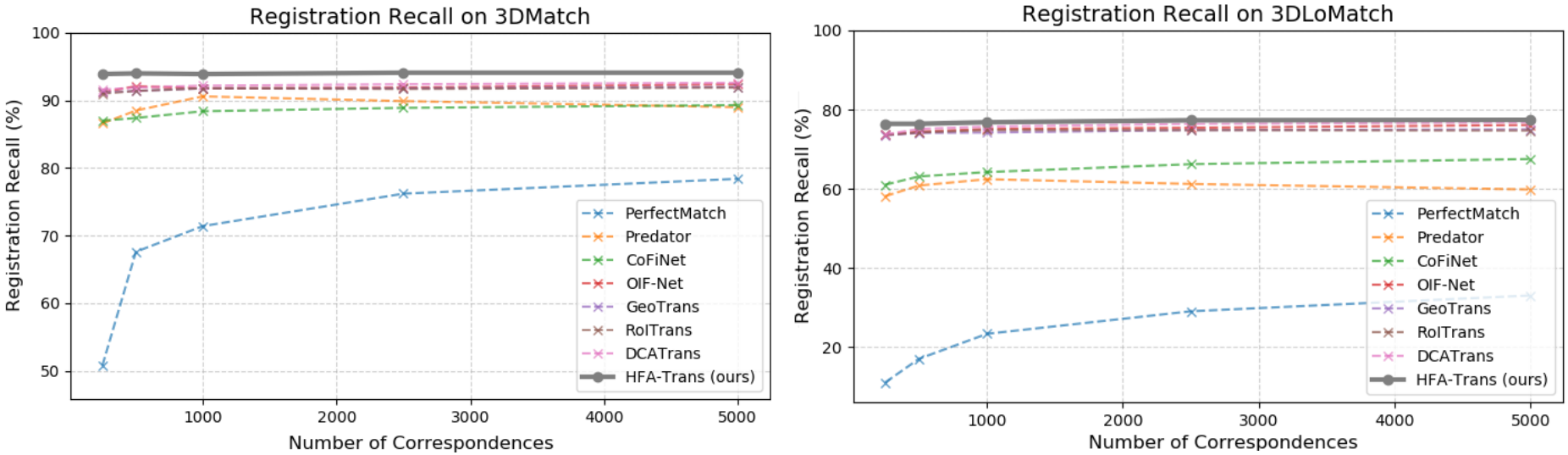
(a)GeoTransformer, Point Correspondences

(b)HFA-Transformer, Point Correspondences

Inlier ratio comparison in a low-overlap scene. Left: Existing methods often struggle with ambiguous features, resulting in a low inlier ratio from incorrect matches. Right: Our proposed HFA-Transformer identifies significantly more correct matches (inliers), demonstrating its superior performance and robustness under challenging conditions.

Main Contributions

- Contributions:
  - A novel point cloud registration network that enhances matching performance and robustness by integrating contextual modeling with multi-level feature fusion;
  - A Global Context and Channel Fusion (GCCF) module that effectively captures global information to provide more discriminative feature representations for matching;
  - A Hierarchical Feature Aggregation (HFA) module that enables precise matching by efficiently fusing multi-level features to model geometric consistency.



Registration Recall comparison on the 3DMatch and 3DLoMatch datasets. Left: On the 3DMatch benchmark, our proposed HFA-Transformer (solid line) demonstrates leading performance. Right: On the more challenging low-overlap 3DLoMatch benchmark, our method shows a significant and stable advantage over all other competing methods.