AutoPCD: Learning-Augmented Indoor Point Cloud Completion

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Background and Motivation

Background

- Complete Point Cloud (PCD) data is important for ubiquitous sensing applications, such as Indoor Robot Localization, Tracking, and VR/AR.
- Collected PCDs are **sparse** and **incomplete** due to the occlusion, limited sensor field of view, and limited scan trajectory.

Motivation

- It requires a lot of time and effort for human/machine to completely scan a large indoor area.
- A machine-learning algorithm to automatically reconstruct complete PCDs from incomplete ones could be an efficient approach.

Challenges and Intuition

Challenges with Reconstructing Large PCDs

- Efficiently extract geometric features from PCDs where points may exist sparsely in any 3D location.
- PCD reconstruction of large indoor environment requires an emphasis on both the local and global structures.
- Large memory cost of processing PCDs of large environments.

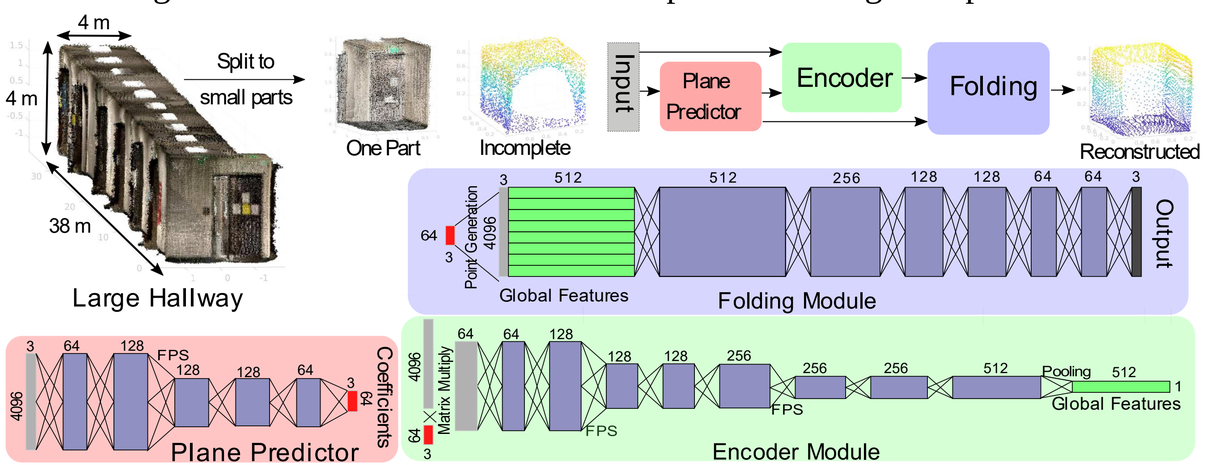
Intuition behind AutoPCD

- Indoor buildings consist of **regular geometric structures**, such as straight walls, and floors that can be **approximated as 3D planes**.
- A large environment could be split into multiple parts, and processing each part saves on memory cost and preserves local geometric structures.

AutoPCD System Design

Graph Neural Network and Folding

- We first use graph neural network based encoder and plane predictor to extract geometric features and planes from incomplete PCD.
- We next generate initial points on predicted planes and concatenate them with global geometric features and then use a Multi-Layer Perceptron based folding network to transform these initial points into target shapes.



Result and Conclusion

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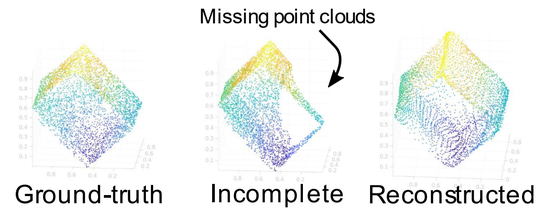
- We evaluate the performance of AutoPCD using two metrics: Chamfer Distance and Structural Similarity (SSIM).

Chamfer Distance	smaller is better
Reconstructed	**0.0030**
Incomplete	0.0121
SSIM	larger is better
Reconstructed	**0.9823**
Incomplete	0.3617



- AutoPCD is successful in reconstructing the incomplete PCD.

Future Works

- Design a framework to automatically split, reconstruct, and merge large indoor PCDs.
- Reconstruct not only the geometric structures but also the color characteristics of PCDs.