3D Content Creation and Refinement in Automotive Applications

The Sphinx Squad

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Content

Introduction: 3D Content Creation Through Point Cloud Reconstruction from 2D Images

- 3D content creation in the automotive industry involves utilizing technical skills to produce high-quality 3D models for various applications, including vehicle design, simulation, and marketing. The reconstruction of 3D models from 2D images significantly aids this process, allowing for more efficient and realistic model creation. This technology enhances the design and visualization of vehicles, enabling better prototyping, virtual testing, and interactive experiences for potential customers through augmented reality (AR) and virtual reality (VR) platforms.

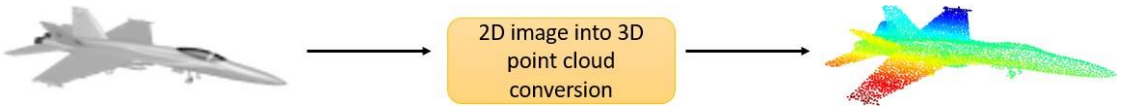


Figure: A visual representation of converting a 2D jet plane image into a 3D point cloud model.

Motivation for 3D Content Creation

- Autonomous Vehicles: Point clouds created through advanced algorithms provide a car's surroundings in 3D, enabling object detection, classification, and real-time environment understanding for safe self-driving.
- Advanced Driver Assistance Systems (ADAS): Algorithm-generated point clouds contribute to features like lane departure warning, automatic emergency braking, and adaptive cruise control by creating a precise 3D perception of the road and surrounding objects.

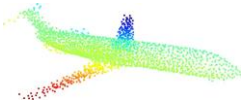


Figure: Plane to Car

Literature Survey: Reconstruction of 3D Point Cloud From 2D image

3D Disentangled Attribute Flow (CVPR 2022)

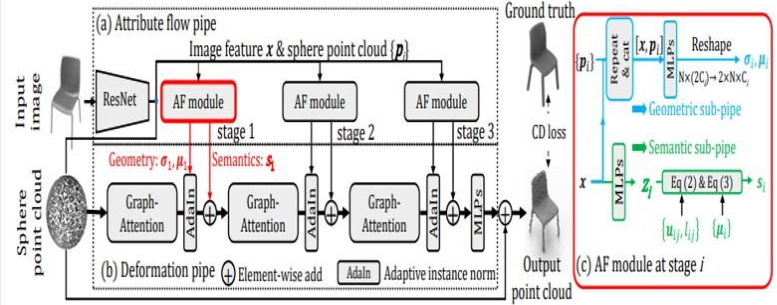


Figure: Architecture of 3D attriflow

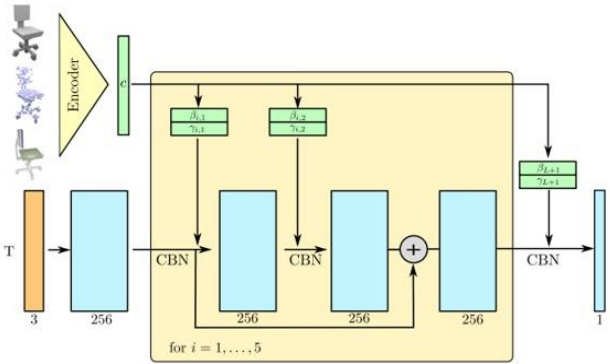
Contributions:

3DAttriFlow can explain semantic features from images, and use them for detailed high-quality 2D-to-3D shape reconstruction

Attribute flow pipe used to disentangle the semantic attributes.

Literature Survey: Reconstruction of 3D Point Cloud From 2D image

Occupancy Networks: Learning 3D Reconstruction in Function Space (CVPR 2019)



Contributions:

New representation for 3D geometry based on learning a continuous 3D mapping.

Representation can be used for reconstructing 3D geometry from various input type.

Figure: Architecture of 3D Occnet

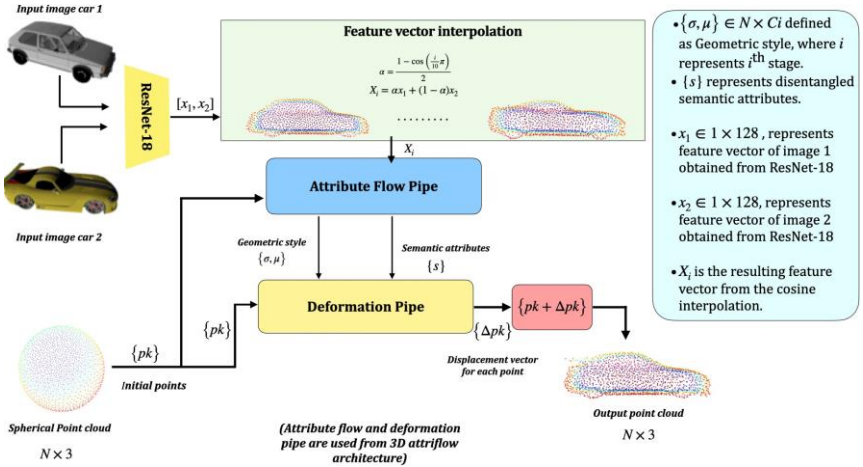
Problem Statement and Objectives

Problem Statement

To create a learning-based algorithm for transforming 2D images into high-quality 3D models towards content creation.

- **Objectives**
  - Extract essential features from a 2D image by employing an architecture.
  - Develop a neural network for generating a 3D point cloud from the extracted features.
  - Vary extracted features of 2D images for creating diverse 3D models towards content creation.

Workflow Towards Content Creation (3D Point Cloud)



ShapeNet Dataset Description

- The dataset used for the evaluation of our model is the ShapeNet dataset.
- It comprises 43,783 mesh objects across 13 categories.
- Categories include Aircraft, Vehicles, Furniture, Electronics, etc.
- The mesh is uniformly sampled to generate 30,000 points.
- These points are used as the ground truth while testing.

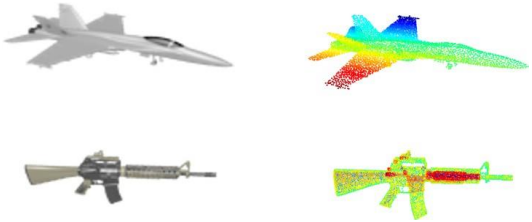


Figure: ShapeNet images along with ground truth

Experimental Results: Transition by Varying Feature Vectors (Intra category)

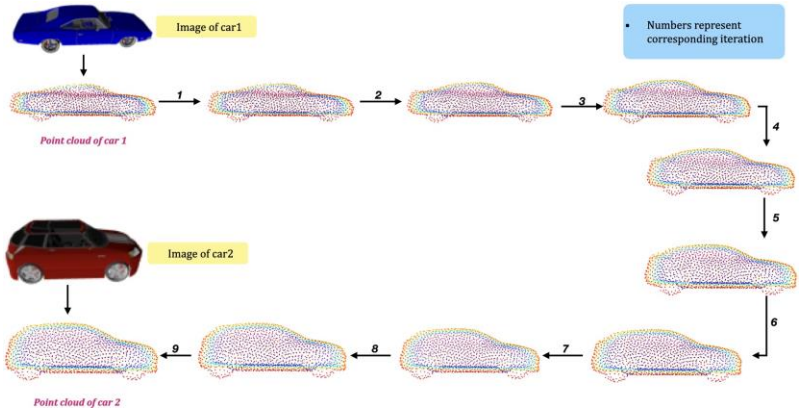


Figure: Transition from Car1 to Car2 with intermediate point clouds.

Experimental Results: Transition by Varying Feature Vectors (Inter category)

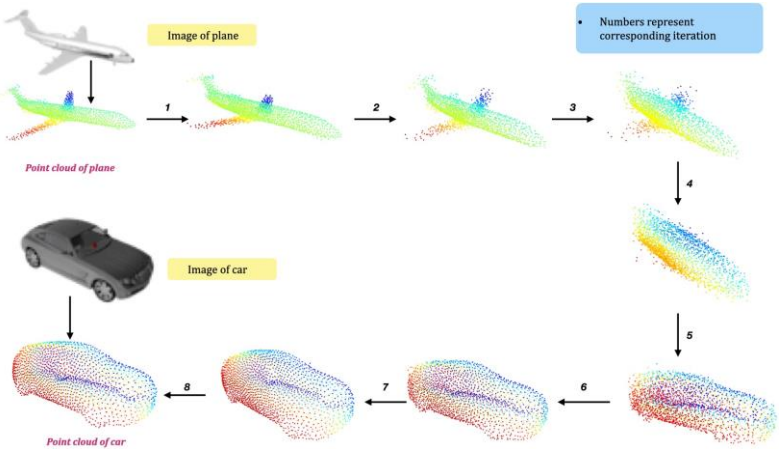


Figure: Transition from Plane to Car with intermediate point clouds.

Experimental Results: Part Exchange of Plane (Wing)

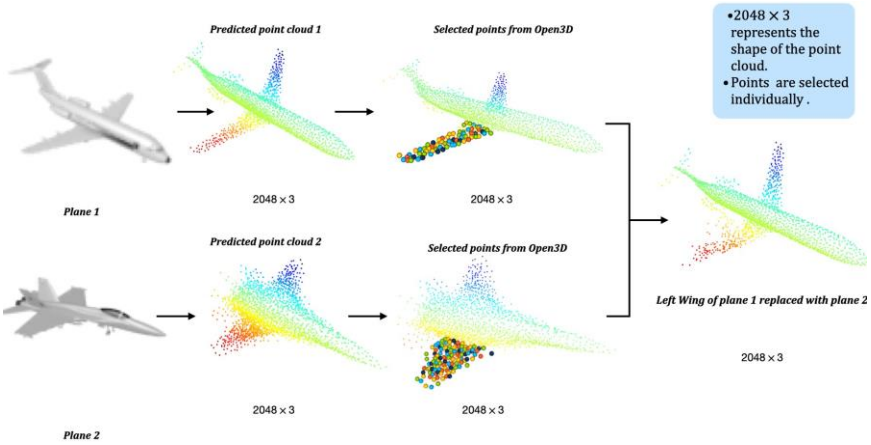
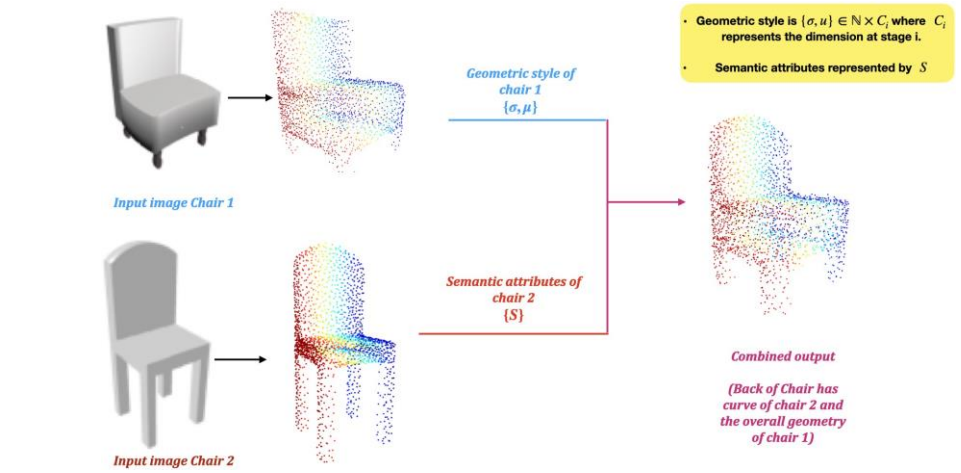


Figure: Changing only the left wing of plane1 with left wing of plane2.

Experimental Results: Combining Geometric Style with Semantic Attributes



Experimental Results: Varying semantic features

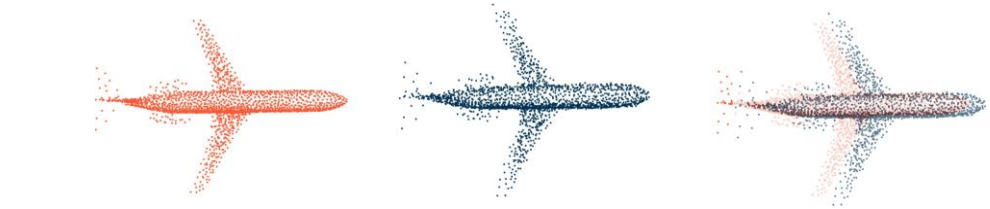


Figure: Varying stage 3 dim 9 causing length variation in wings (Red shows unvaried point cloud)

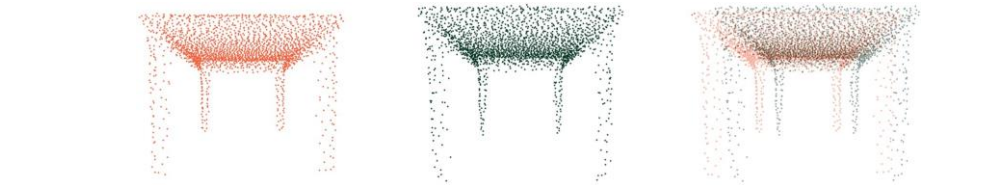


Figure: Varying stage 3 dim 2 causing increase in length of legs (Red shows unvaried point cloud)

Experimental Results: Point cloud from OccNet and 3D AttributeFlow

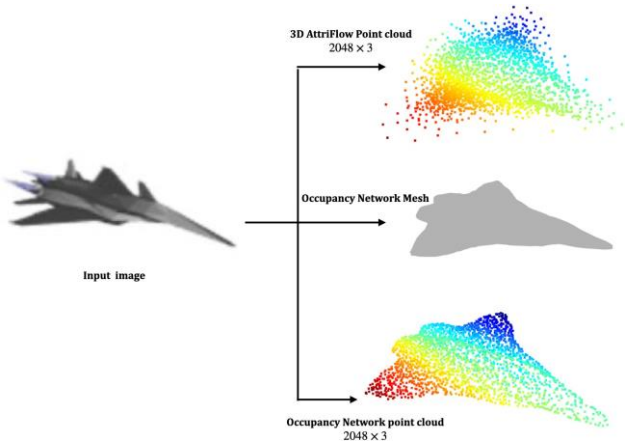


Figure: Point cloud generated from OccNet demonstrates a smoother finish on certain images, due to its implicit representation capabilities.

Conclusion

- In conclusion, the workflow for 3D content creation by converting single-view 2D images into 3D point clouds was implemented across vehicle models. This process generates new content by varying the latent representation of the image and can be used to enhance vehicle design, prototyping, and virtual testing, as well as improve customer experiences through AR and VR applications.

References I

- Xin Wen1, Junsheng Zhou1, Yu-Shen Liu1, Hua Su3, Zhen Dong4, Zhizhong Han. ”3D Shape Reconstruction from 2D Images with Disentangled Attribute Flow”.
- Lars Mescheder, Michael Oechsle, Michael Niemeyer, Sebastian Nowozin, Andreas Geiger. ”Occupancy Networks: Learning 3D Reconstruction in Function Space”.