

3D Car Shape Reconstruction from a Single Sketch Image

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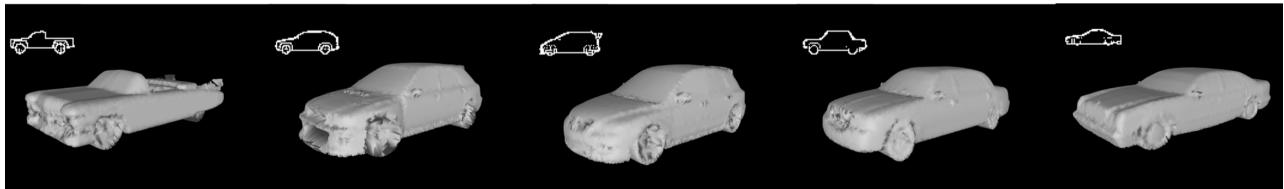


Figure 1: The 3D car shapes generated by our system from 2D sketch inputs.

ABSTRACT

Efficient car shape design is a challenging problem in both the automotive industry and the computer animation/games industry. In this paper, we present a system to reconstruct the 3D car shape from a single 2D sketch image. To learn the correlation between 2D sketches and 3D cars, we propose a Variational Autoencoder deep neural network that takes a 2D sketch and generates a set of multi-view depth & mask images, which are more effective representation comparing to 3D mesh, and can be combined to form the 3D car shape. To ensure the volume and diversity of the training data, we propose a feature-preserving car mesh augmentation pipeline for data augmentation. Since deep learning has limited capacity to reconstruct fine-detail features, we propose a lazy learning approach that constructs a small subspace based on a few relevant car samples in the database. Due to the small size of such a subspace, fine details can be represented effectively with a small number of parameters. With a low-cost optimization process, a high-quality car with detailed features is created. Experimental results show that the system performs consistently to create highly realistic cars of substantially different shape and topology, with a very low computational cost.

CCS CONCEPTS

• **Computing methodologies** → **Computer graphics**; *Shape modelling*; • **Computer vision problems** → **Reconstruction**.

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KEYWORDS

Deep Learning, Lazy Learning, 3D Reconstruction, Sketch-based Interface, Car

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1 INTRODUCTION

Car shape design is a common area in automotive manufacturing, computer animation and games. The design process is time-consuming and labour intensive, as it is a combination of arts and engineering. In this paper, we propose a new 3D car design interface that is based on a single 2D sketch, which contains only the outline information on the cars' shape. Since a single outline sketch cannot provide enough information on 3D car reconstruction, our new framework estimates such missing information from a 3D car shape database. The major contributions of this paper are summarized as follows:

- We propose a feature-preserving mesh augmentation framework to construct a large car database with pairwise 3D mesh and 2D sketch, based on the small number of car meshes in ShapeNet [2].
- We propose a Variational Autoencoder (VAE) [3] deep learning network to learn the correlation between a 2D sketch and the corresponding rough 3D shape.
- We propose a lazy learning algorithm to learn a local subspace to reconstruct the fine detail features of the car from the rough shape.

