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Deep3DSketch-im: rapid high-fidelity AI 3D model generation by single freehand sketches

Key words: Content creation; Sketch; Three-dimensional (3D) modeling; 3D reconstruction; Shape from X; Artificial intelligence (AI)

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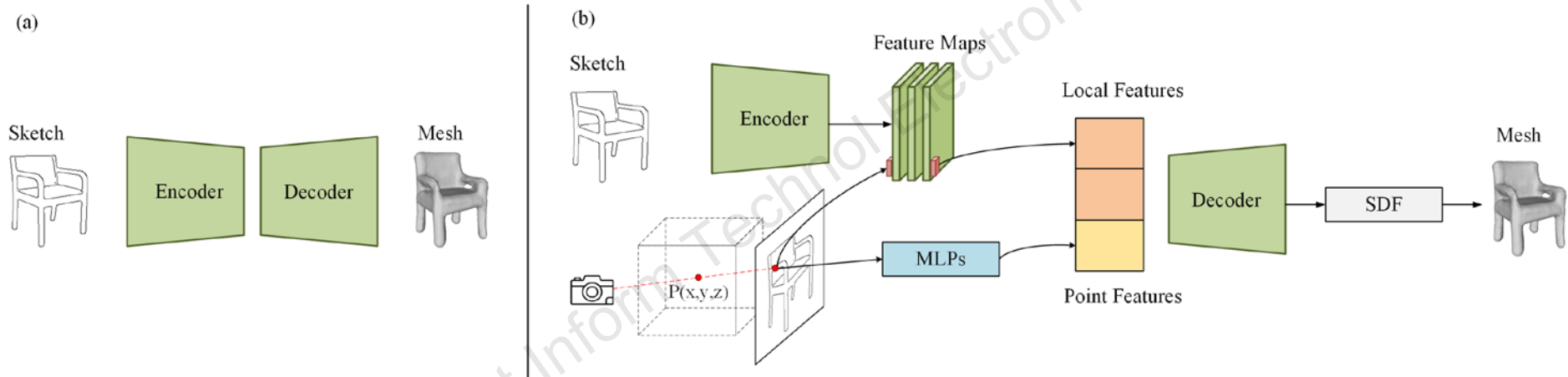
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Motivation

- The rise of artificial intelligence generated content (AIGC) has been remarkable in the language and image fields, but artificial intelligence (AI) generated three-dimensional (3D) models are still under-explored due to their complex nature and lack of training data. The conventional approach of creating 3D content through computer-aided design (CAD) is labor-intensive and requires expertise, making it challenging for novice users.
- To address this issue, we propose a sketch-based 3D modeling approach, Deep3DSketch-im, which uses a single freehand sketch for modeling.

Framework



Network architecture

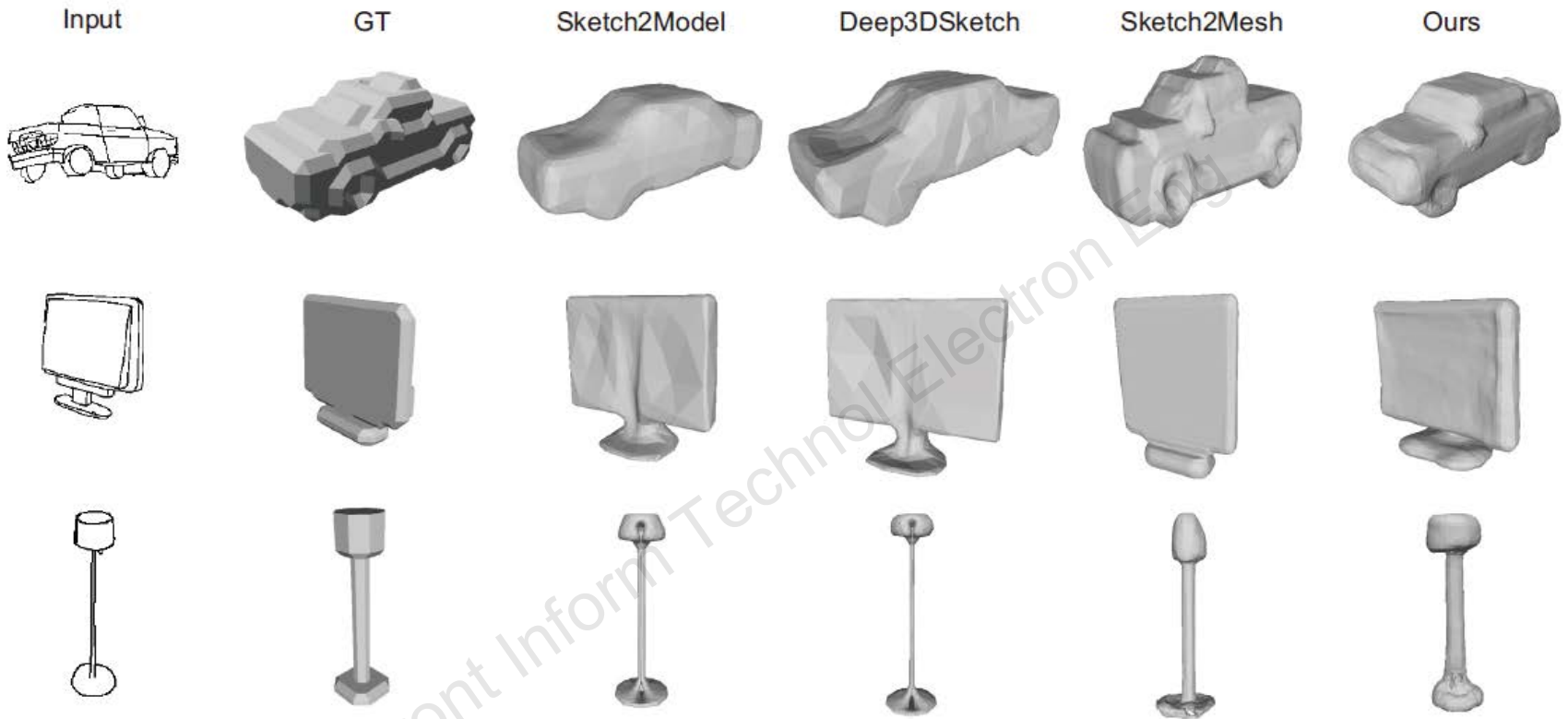
Method

- Our approach uses a deep learning based approach that learns to interpret the abstract representation of sketches and reconstructs a high-quality 3D mesh.
- Our objective is to generate a highly detailed and accurate 3D model of an object from a given image. To achieve this, we adopt a novel approach that represents the 3D shape as a signed distance field (SDF). By representing the shape as an SDF, we can model the object surface as a level set of the function, allowing us to generate a high-resolution mesh of the object surface.
- In implementation, we first define a dense 3D grid and predict signed distance function values for each point in the grid. With these values calculated, we can then use the Marching Cubes algorithm to obtain the 3D mesh that corresponds to the iso-surface S' .

Method

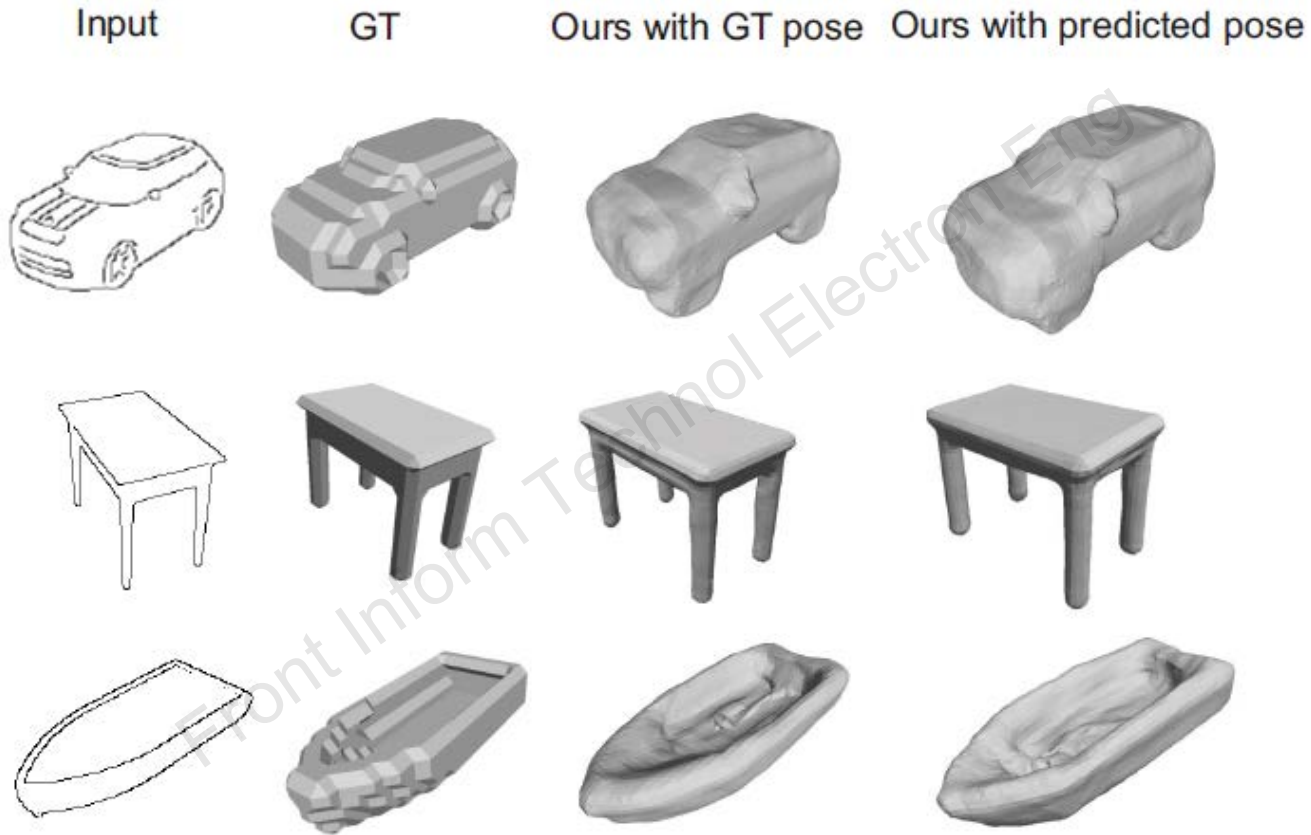
- Following the approach adopted in Chen TR et al. (2023a, 2023c), we design a separate pose-estimation network and train it in a fully supervised manner. We use an encoder E to produce latent code z_l from the sketches and input it to the viewpoint prediction module, which consists of two fully connected layers D_v aimed at producing the viewpoint estimate ξ_{pred} , represented by an Euler angle.
- We adopt a continuous signed distance function regression approach that allows us to extract surfaces.

Major results



Qualitative evaluation with state-of-the-art (SOTA) method for a real-world dataset

Major results



Qualitative evaluation with predicted pose

Conclusions

We have presented a novel deep learning network, Deep3DSketchim, for generating 3D models from a single 2D sketch. Considering the lack of fine details characterizing the existing sketch-to-model approaches, we first introduce SDF to represent the 3D shape for infinite resolution. We design a network to capture the local features for fine-grained structure 3D modeling. Through experiments on the ShapeNet-Synthetic dataset, we have shown that our approach outperforms SOTA methods in terms of both quantitative metrics and user study ratings. Our method also expands the existing language- or vision-centered AIGC tools. We believe that our study opens up exciting possibility for creating 3D content from simple 2D sketches, which can have significant applications in industries such as gaming, animation, and architecture.



Tianrun CHEN received his BS degree from the College of Information Science and Electronic Engineering, Zhejiang University, China, and is pursuing his PhD degree at the College of Computer Science and Technology, Zhejiang University. He is the founder and technical director of Moxin (Huzhou) Technology Co., Ltd, China. His research interests include computer vision and its enabling applications.



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Lingyun SUN is a professor at the College of Computer Science and Technology, Zhejiang University, China. He obtained a PhD degree from Zhejiang University. His research revolves around AI and design, aiming to equip the design industry with AI capabilities and to enhance design tools and methodologies in the AI era. He has developed image and video generation platforms that can create visual content, short videos, and other digital materials.