Sketch-to-CAD: A Deep Learning Approach for Predicting CAD Steps from Isometric Sketches

Stanford CS231N Project

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1 Project Proposal

Computer Aided Design (CAD) is a technology leveraged in many engineering disciplines for 3D design, development, and simulation analysis. The process of translating a 2D isometric sketch to a 3D file is laborious and time consuming. Development of a pipeline for 3D design that provides an adjustable model timeline to allow fine-tuning of a 3D model increases accessibility to 3D design and presents an opportunity to revolutionize workflows globally.

Prior works have explored the use of sketching in the context of Computer Aided Design (CAD). One of the seminal works in this area is "Sketch2CAD: Sequential CAD Modeling by Sketching in Context" [1], which proposes a system for automatically converting 2D sequential sketches into 3D CAD models. The system uses a neural network to interpret the sketch and generate a 3D model, with the added feature, allowing users to refine the model through additional sketches.

Another related work is "A 2D Sketch-Based User Interface for 3D CAD" [2], which presents a user interface that allows users to search for and retrieve 3D CAD models based on sketches. This system typically use similarity metrics to match input sketches with existing models in a database.

For our project, the data inputs will be isometric sketch views of CAD models using the following Fusion 360 Data `https://github.com/AutodeskAILab/Fusion360GalleryDataset/blob/master/docs/reconstruction.md` [3]. A Fusion 360 API will enable reading in a JSON file to a specific 3D design to then save an isometric sketch view as a png file. Ground truth data is also obtained from the JSON files in the form of a vector representation of the extrusion steps needed to reconstruct the CAD model. The vector will contain information about the plane of a sketch as well as the points, curves, and extrude information.

We anticipate implementing a standard CNN architecture such as VGG-16 or Inception-v3 as a starting point for the 2D isometric view sketch inputs. Once we obtain a fully-connected layer, we will tune additional layers on the output ground truth data.

Model evaluation will include a qualitative component of inspecting the resulting CAD file. There should be timelines and realistic extrusions. The quantitative evaluation will include mean squared error (MSE) for the positions of sketch points and extrude information.

References

[1] Changjian Li, Hao Pan, Adrien Bousseau, and Niloy J Mitra. Sketch2cad: Sequential cad modeling by sketching in context. *ACM Transactions on Graphics (TOG)*, 39(6):1–14, 2020.

[2] Jiantao Pu, Kuiyang Lou, and Karthik Ramani. A 2d sketch-based user interface for 3d cad model retrieval. *Computer-aided design and applications*, 2(6):717–725, 2005.

[3] Karl DD Willis, Yewen Pu, Jieliang Luo, Hang Chu, Tao Du, Joseph G Lambourne, Armando Solar-Lezama, and Wojciech Matusik. Fusion 360 gallery: A dataset and environment for programmatic cad construction from human design sequences. *ACM Transactions on Graphics (TOG)*, 40(4):1–24, 2021.