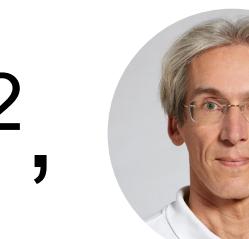


Yujia Liu¹,Anton Obukhov¹,Jan Dirk Wegner²,Konrad Schindler¹

Introduction

Point2CAD reconstructs complex CAD models from 3D point clouds. A point cloud is segmented into clusters corresponding to CAD faces. Each face is fitted with a geometric primitive or a parametric surface using a novel neural representation (INR). Due to the analytic representation, the surfaces can be extended and intersected to obtain topology, which is then used to clip the primitives and obtain B-rep format. Point2CAD sets a state-of-the-art on ABC benchmark of CAD models.

Proposed Method



Fig. Point2CAD pipeline for reconstructing CAD models: segmenting clusters, fitting geometric primitives or freeform surfaces, extending and intersecting these surfaces to form the topology.

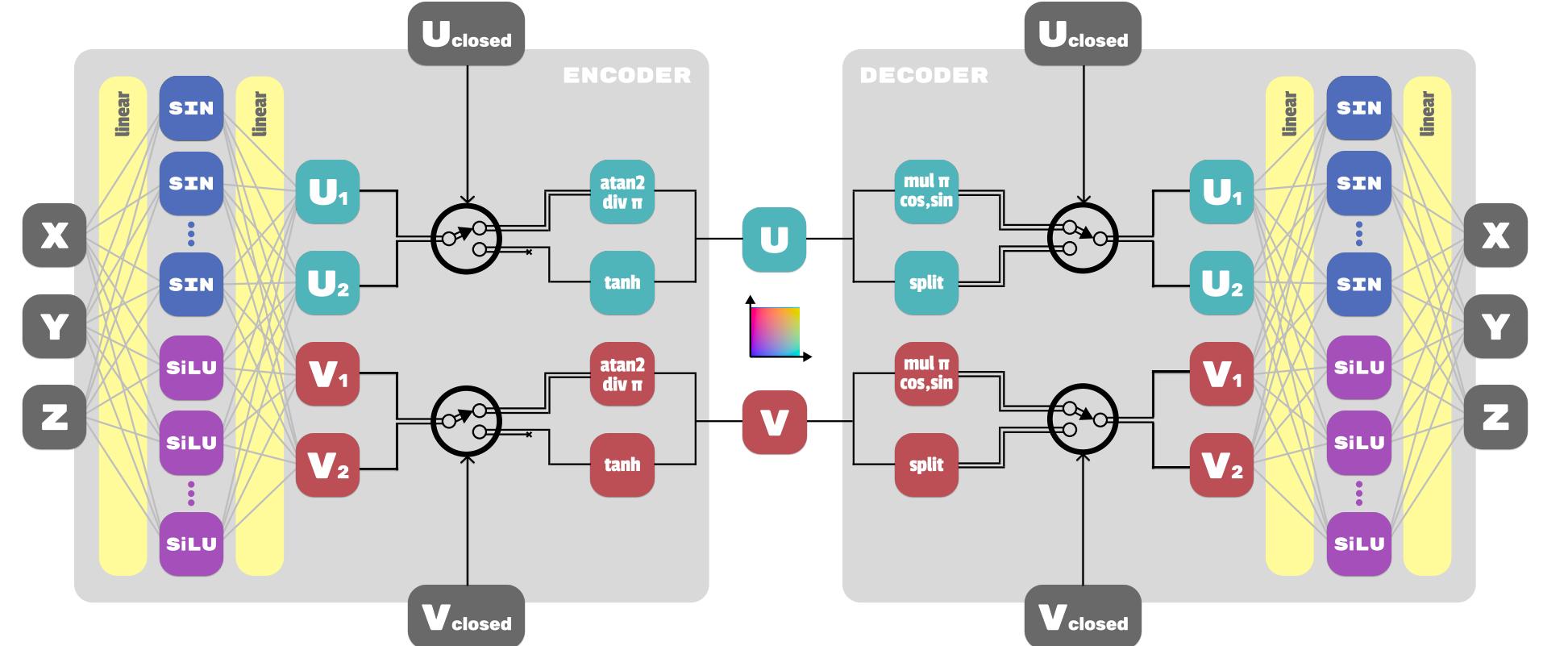
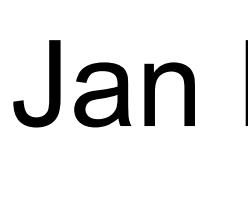


Fig. The novel INR design of smooth freeform surfaces (open and closed).

Point2CAD: Reverse Engineering CAD Models from 3D Point Clouds

Jan Dirk Wegner²,Konrad Schindler¹¹ETH Zürich,²University of Zürich

Experimental results

Tab. Evaluation of surfaces, edges and corners reconstruction metrics on the ABC dataset.

Method	Segmentation	Surfaces			$\theta_{\text{surface}} = 0.08$			$\theta_{\text{surface}} = 0.06$			$\theta_{\text{surface}} = 0.03$		
		precision ↑	recall ↑	F-score ↑	precision ↑	recall ↑	F-score ↑	precision ↑	recall ↑	F-score ↑	precision ↑	recall ↑	F-score ↑
ComplexGen	N/A	0.732	0.732	0.731	0.633	0.641	0.637	0.370	0.388	0.379			
Point2CAD	ParseNet	0.817	0.750	0.782	0.764	0.693	0.727	0.624	0.562	0.591			
Point2CAD	HPNet	0.836	0.745	0.788	0.796	0.695	0.742	0.697	0.593	0.641			
Point2CAD	GT	0.976	0.920	0.947	0.962	0.898	0.929	0.873	0.801	0.836			
Edges		$\theta_{\text{edge}} = 0.05$			$\theta_{\text{edge}} = 0.03$			$\theta_{\text{edge}} = 0.02$					
Method	Segmentation	precision ↑	recall ↑	F-score ↑	precision ↑	recall ↑	F-score ↑	precision ↑	recall ↑	F-score ↑	precision ↑	recall ↑	F-score ↑
ComplexGen	N/A	0.620	0.576	0.597	0.421	0.397	0.409	0.291	0.279	0.285			
Point2CAD	ParseNet	0.636	0.596	0.615	0.523	0.486	0.504	0.440	0.414	0.427			
Point2CAD	HPNet	0.637	0.586	0.611	0.526	0.473	0.498	0.449	0.397	0.421			
Point2CAD	GT	0.863	0.774	0.816	0.766	0.673	0.717	0.686	0.597	0.639			
Corners		$\theta_{\text{corner}} = 0.03$			$\theta_{\text{corner}} = 0.02$			$\theta_{\text{corner}} = 0.01$					
Method	Segmentation	precision ↑	recall ↑	F-score ↑	precision ↑	recall ↑	F-score ↑	precision ↑	recall ↑	F-score ↑	precision ↑	recall ↑	F-score ↑
ComplexGen	N/A	0.667	0.633	0.650	0.483	0.454	0.468	0.217	0.203	0.210			
Point2CAD	ParseNet	0.661	0.641	0.651	0.553	0.529	0.541	0.398	0.392	0.395			
Point2CAD	HPNet	0.646	0.613	0.629	0.549	0.521	0.535	0.389	0.386	0.388			
Point2CAD	GT	0.780	0.696	0.736	0.704	0.662	0.661	0.581	0.515	0.546			



Fig. Visualization of the input point cloud, GT mesh, and reconstruction by different methods.

Tab. Comparison of free-form surface fitting. ComplexGen and ParseNet generates 20x20 control-points grid. Ours uses the INR surface.

	Open surfaces		Closed surfaces	
	Res-err ↓	P-cover ↑	Res-err ↓	P-cover ↑
ComplexGen	0.021	0.938	0.023	0.900
ParseNet	0.006	0.930	0.008	0.902
Ours	0.002	0.999	0.003	0.998

Tab. Geometric evaluation of reconstructed CADs. Segmentation point cloud clustering method. "GT" stands for oracle ground truth segmentation.

	Segmentation	Res-err ↓	P-cover ↑	Chamfer ↓
	N/A	0.020	0.950	0.042
Point2CAD	ParseNet	0.018	0.942	0.017
Point2CAD	HPNet	0.020	0.937	0.018
Point2CAD	GT	0.011	0.968	0.016

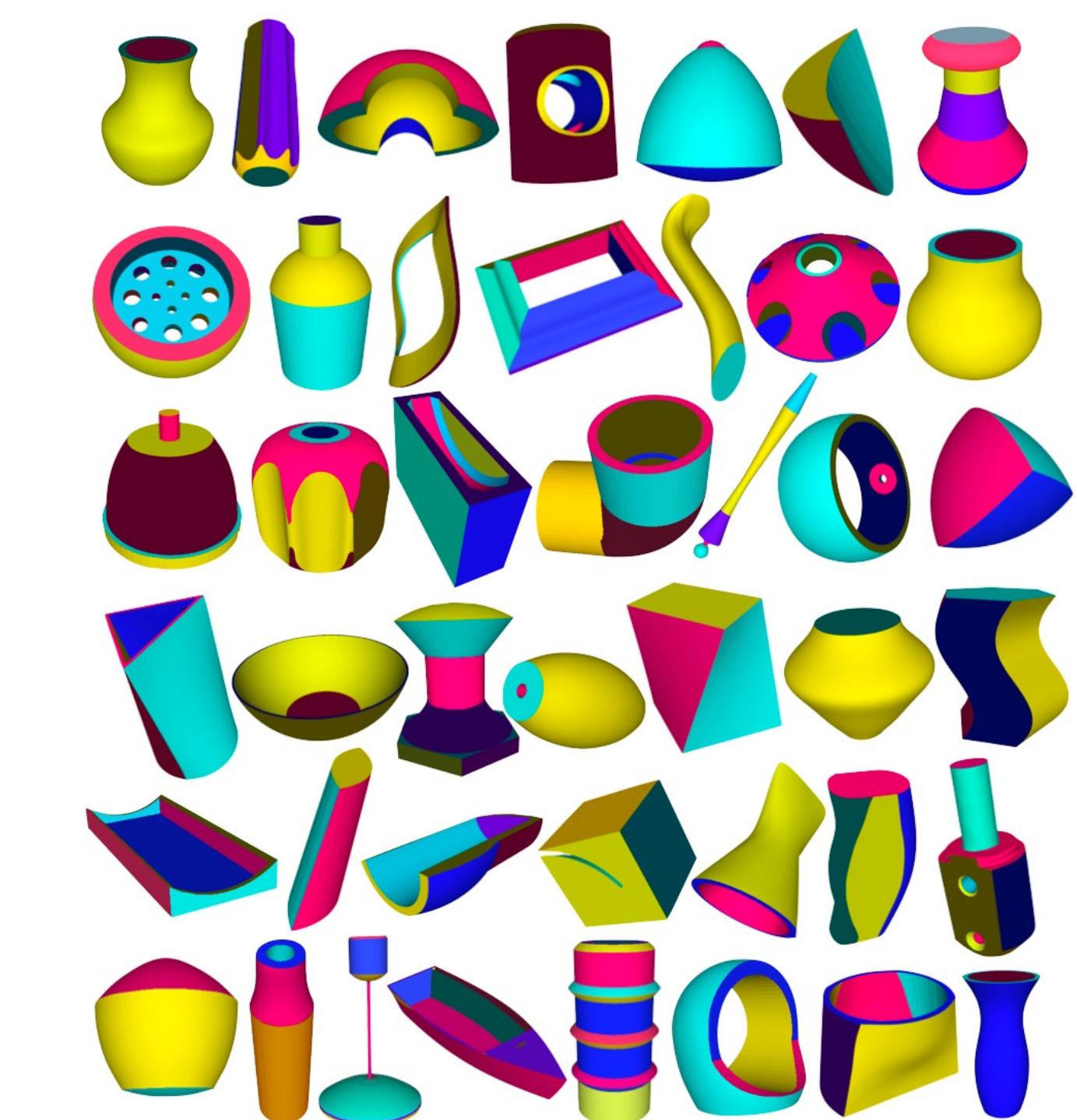


Fig. Selected reconstructions including free-form surfaces.