ETH zürich

PREDATOR: Registration of 3D Point Clouds with Low Overlap





Shengyu Huang*, Zan Gojcic*, Mikhail Usvyatsov, Andreas Wieser, Konrad Schindler Institute of Geodesy and Photogrammetry, ETH Zürich

Motivation

- Performance drop in low overlap regime
- Sampling interest points in overlap region recovers performance drop





overlap ratio = 0.1

overlap ratio = 0.3



overlap ratio = 0.5





PREDATOR

- Point Cloud **Re**gistration with **D**eep **AT**tention to **O**verlap **R**egion
- Predict point-wise features, overlap and matchability scores
- · Probabilistic interest point sampling over the product of overlap and matchability scores





Overlap attention module

- Self-attention GNN to further aggregate local context
- Cross-attention transformer to learn co-contextual information
- Self-attention GNN to smooth out conditioned features and overlap scores

 $Loss = L_{features} + L_{overlap} + L_{matchability}$

- Circle loss for metric learning
- Weighted BCE loss for overlap and matchability scores

• Probabilistic sampling outperforms top-k sampling









Network architecture

Interest point sampling

Experimental results



• **3DMatch:** Indoor scans from RGB-D fusion

	3DMatch				3DLoMatch					
# Samples	5000	2500	1000	500	250	5000	2500	1000	500	250
	Registration Recall (%)									
3DSN	78.4	76.2	71.4	67.6	50.8	33.0	29.0	23.3	17.0	11.0
FCGF	85.1	84.7	83.3	81.6	71.4	40.1	41.7	38.2	35.4	26.8
D3Feat	81.6	84.5	83.4	82.4	77.9	37.2	42.7	46.9	43.8	39.1
Predator	<u>88.3</u>	<u>88.3</u>	89.0	<u>88.4</u>	<u>84.7</u>	<u>54.2</u>	<u>55.8</u>	<u>56.7</u>	<u>56.1</u>	<u>50.7</u>
bigPredator	88.4	89.9	<u>88.8</u>	88.7	85.0	58.0	58.3	57.7	56.8	51.8

Ablation study

overlap attention			3DMatch			3DLoMatch			
ov.	×ov.	cond.	FMR	IR	RR	FMR	IR	RR	
			96.4	39.6	82.6	72.2	14.5	38.9	
1			96.2	47.2	86.9	71.8	<u>18.0</u>	50.9	
1	1		96.1	<u>47.8</u>	<u>87.3</u>	69.5	15.8	48.4	
1		1	95.5	46.4	87.1	73.0	17.6	54.4	
1	1	1	96.6	49.9	88.3	71.7	20.0	<u>54.2</u>	



• odometryKITTI: Outdoor scans from 64-beam Velodyne scanner

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Method	RTE [cm] \downarrow	<i>RRE</i> [°] \downarrow	$\mathbf{RR}\uparrow$	1 Stores and
3DFeat-Net	25.9	0.57	96.0	C. Bar
FCGF	9.5	0.30	96.6	
D3Feat*	<u>7.2</u>	0.30	99.8	NEL CONTRACTOR
PREDATOR (rand)	8.9	0.36	99.6	J. Andrewski and a start of the
PREDATOR (prob. (om))	6.8	0.27	99.8	



• **Modelnet:** Object-centric synthetic dataset from CAD models

	ModelNet			ModelLoNet			
Methods	RRE	RTE	CD	RRE	RTE	CD	
DCP-v2	11.975	0.171	0.0117	16.501	0.300	0.0268	
RPM-Net	1.712	0.018	0.00085	7.342	0.124	0.0050	
PREDATOR (rand)	2.923	0.034	0.00122	11.585	0.181	0.0104	
PREDATOR (prob. (om))	<u>1.856</u>	<u>0.019</u>	0.00088	5.462	<u>0.133</u>	<u>0.0079</u>	









