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SE-ORNet: Self-Ensembling Orientation-aware Network for Unsupervised Point Cloud Shape Correspondence

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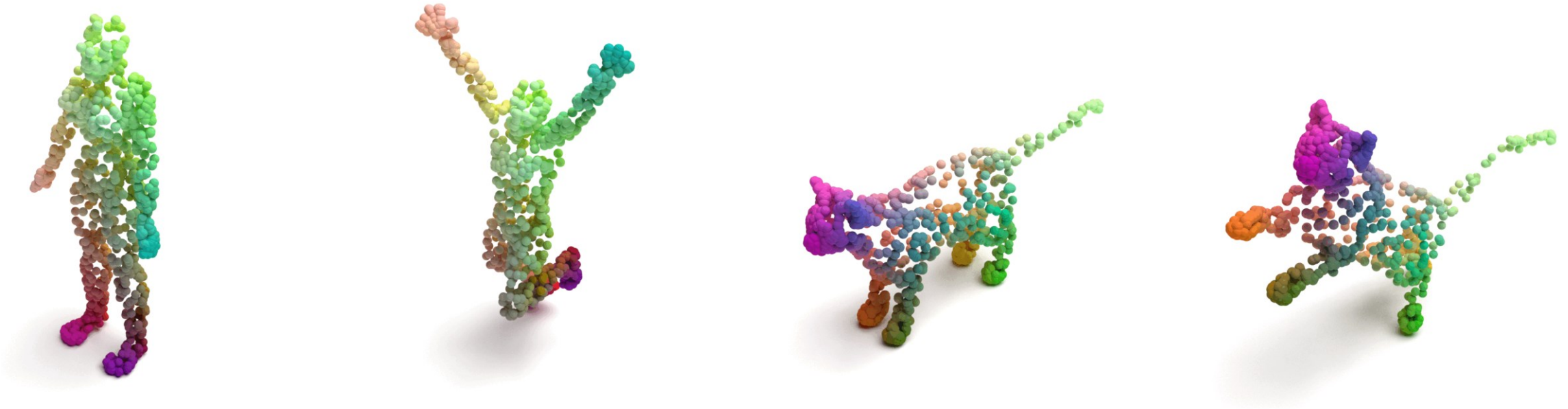
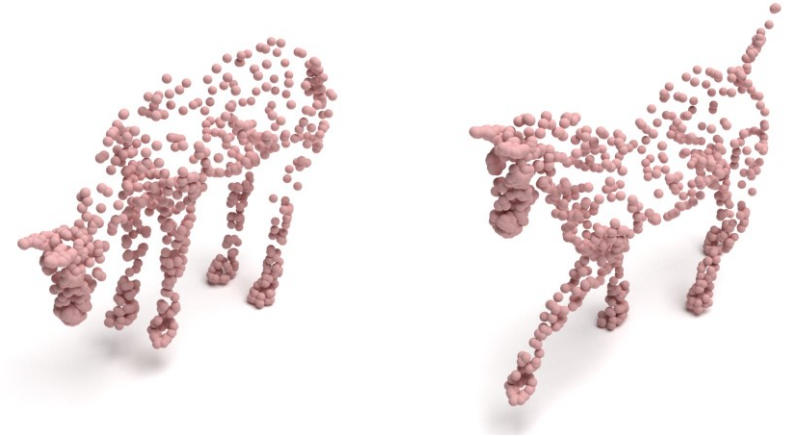
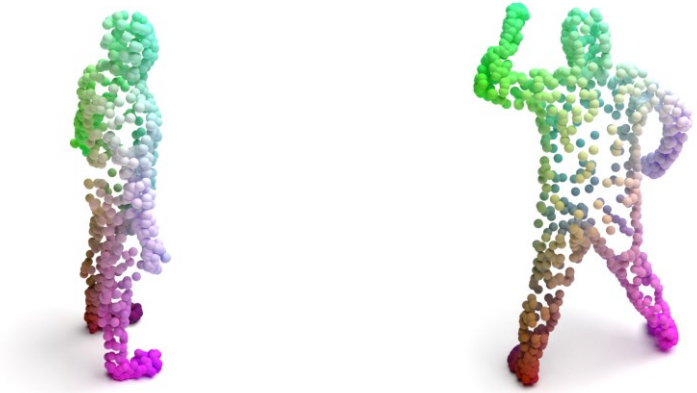


Task Introduction



Input
a pair of point clouds
$2 \times N \times 3$

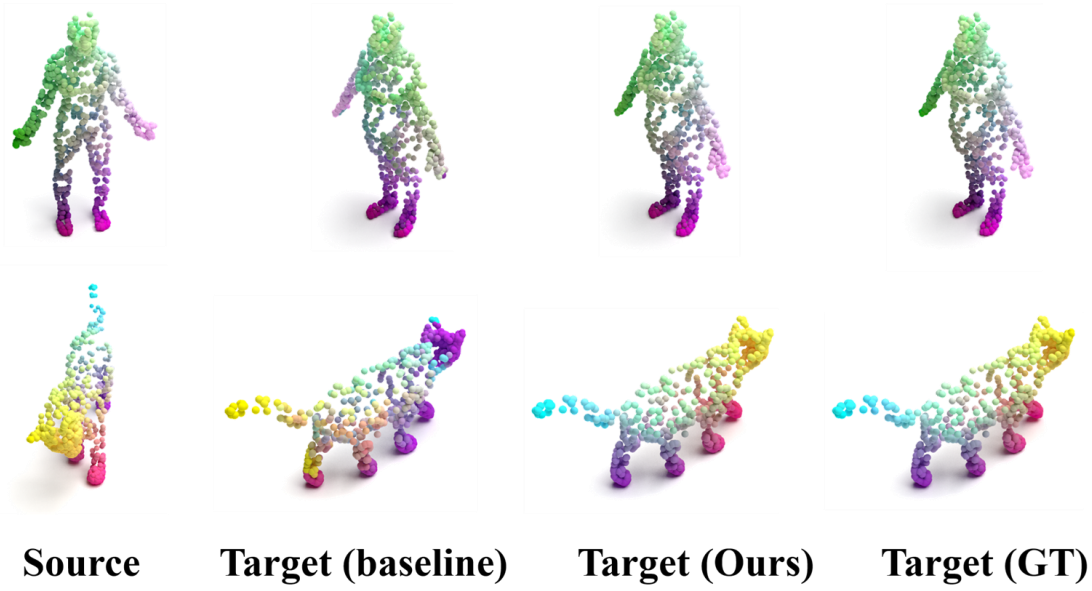
Output
point-to-point
correspondence
$N \times N$



Challenges

☐ Symmetrical Part Mismatching

It is difficult to distinguish the correspondence between ***symmetrical*** parts with different body ***orientations***.



Source Target (baseline) Target (Ours) Target (GT)

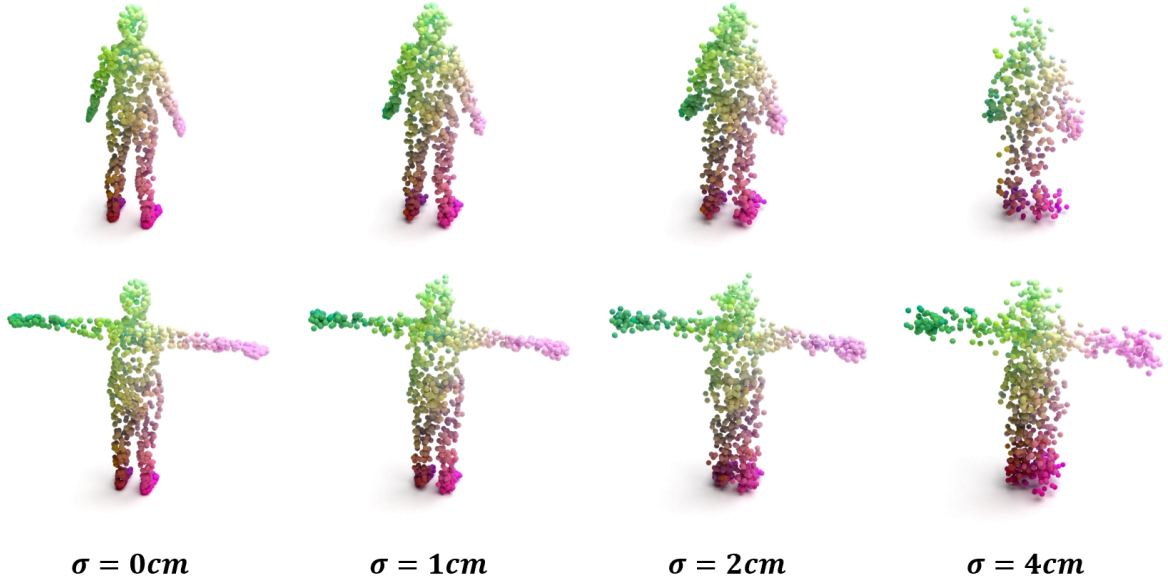
Challenges

☐ Symmetrical Part Mismatching

It is difficult to distinguish the correspondence between ***symmetrical*** parts with different body ***orientations***.

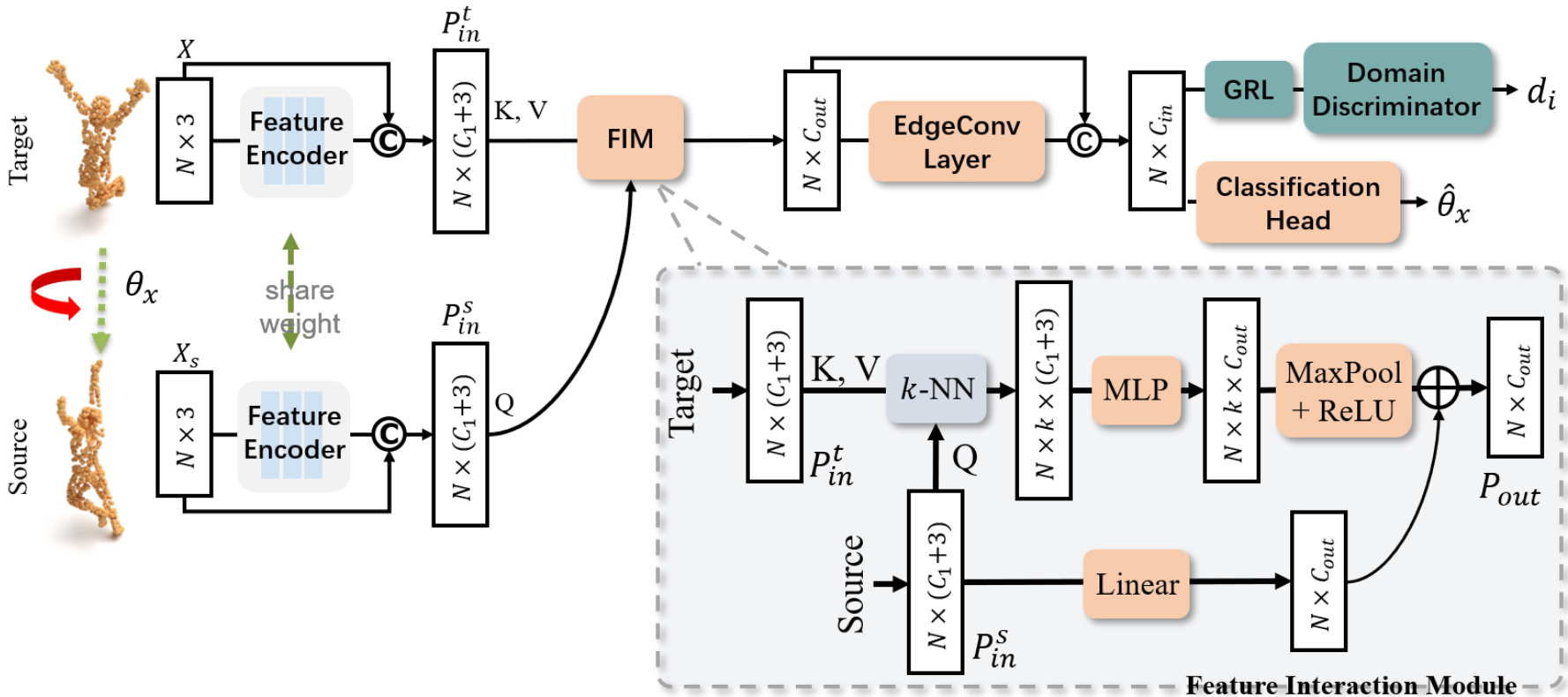
☐ Noise Interference

Point cloud noise perturbs the spatial coordinates of point cloud and interferes with ***local structure modeling***.



Orientation Estimation Module

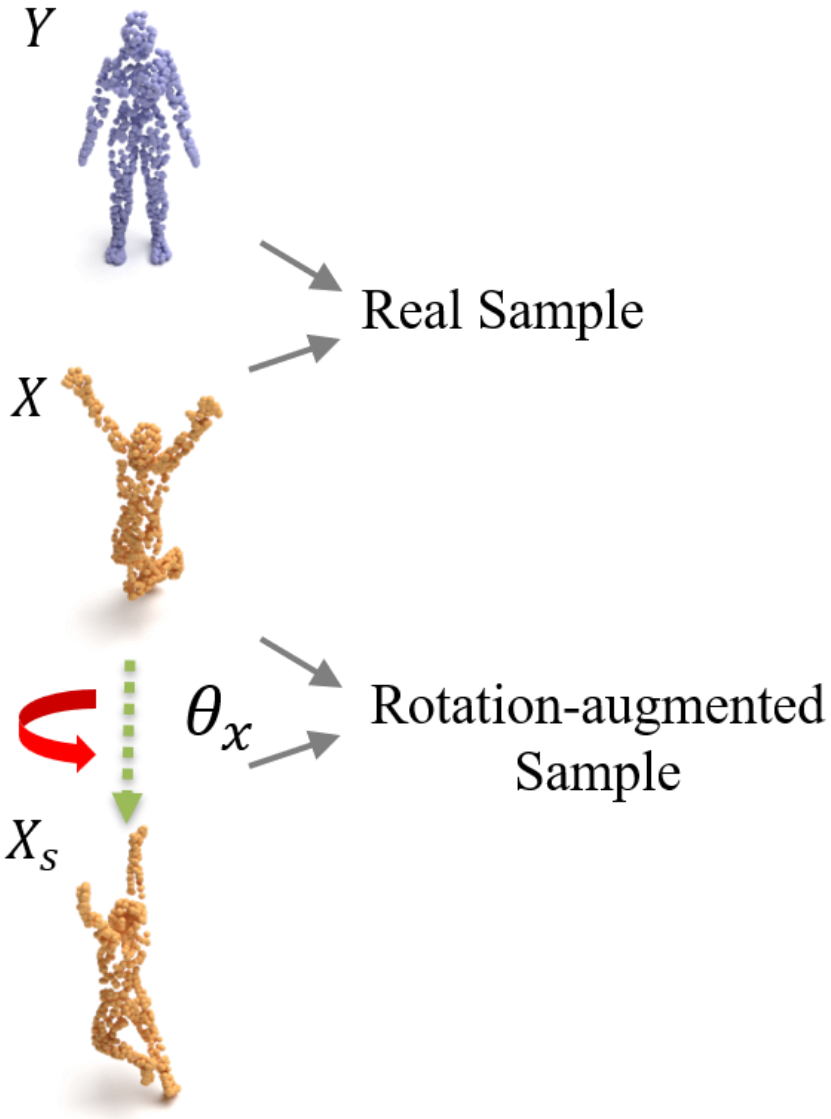
We design a lightweight **Orientation Estimation Module** that accurately ***aligns the orientations*** of point cloud pairs to achieve correct matching results of symmetrical parts.



Adversarial Domain Adaptation

☐ OEM learning

Due to ***the absence of relative rotation angle of the real samples***, we utilize the relative rotation angle of ***the rotation-augmented samples*** to guide the OEM learning.



Adversarial Domain Adaptation

☐ OEM learning

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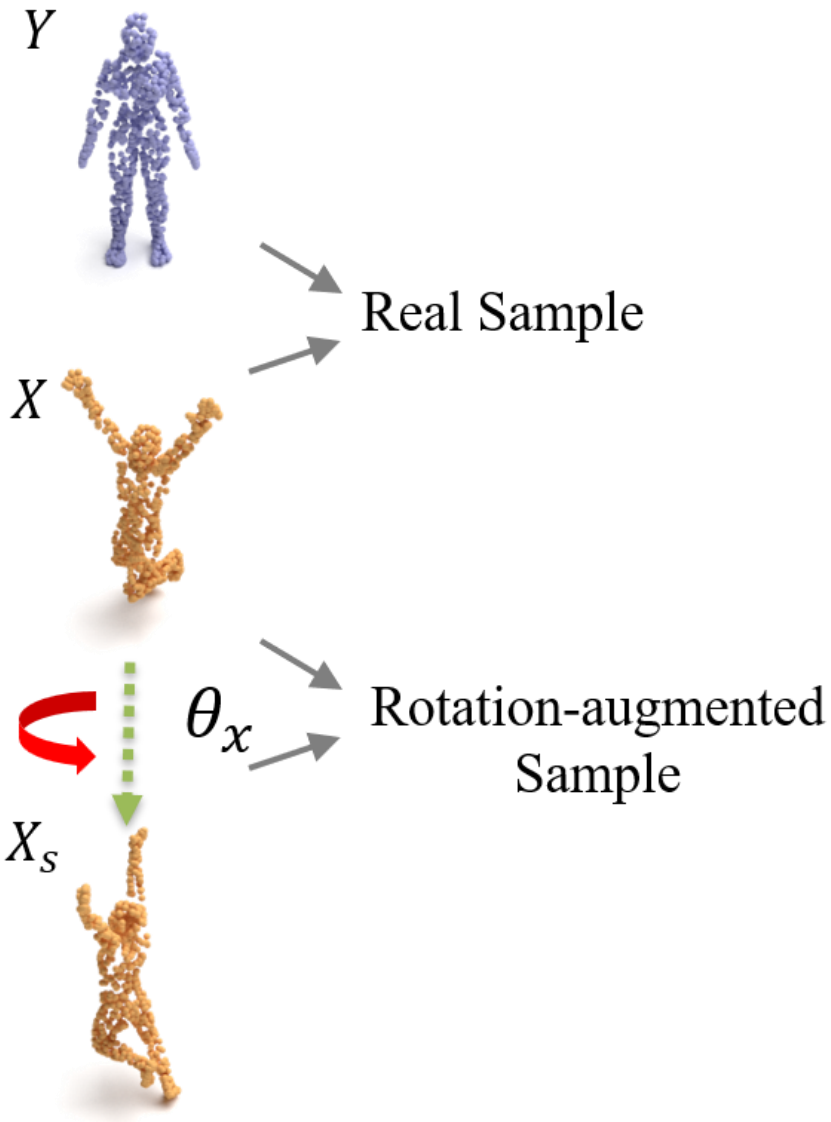
☐ To eliminate the domain gap

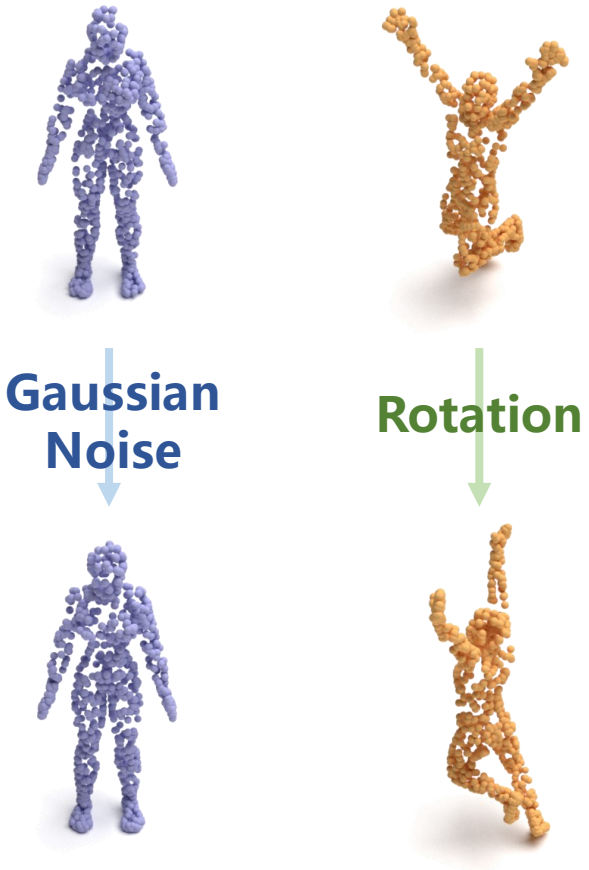
we use a ***discriminator*** to identify whether the input features of the classification head are from real samples or not.



Self-Ensembling Framework

☐ Stochastic Transform

We apply ***rotation*** and ***Gaussian noise*** on the point clouds for the student network formulated.



Self-Ensembling Framework

☐ Stochastic Transform

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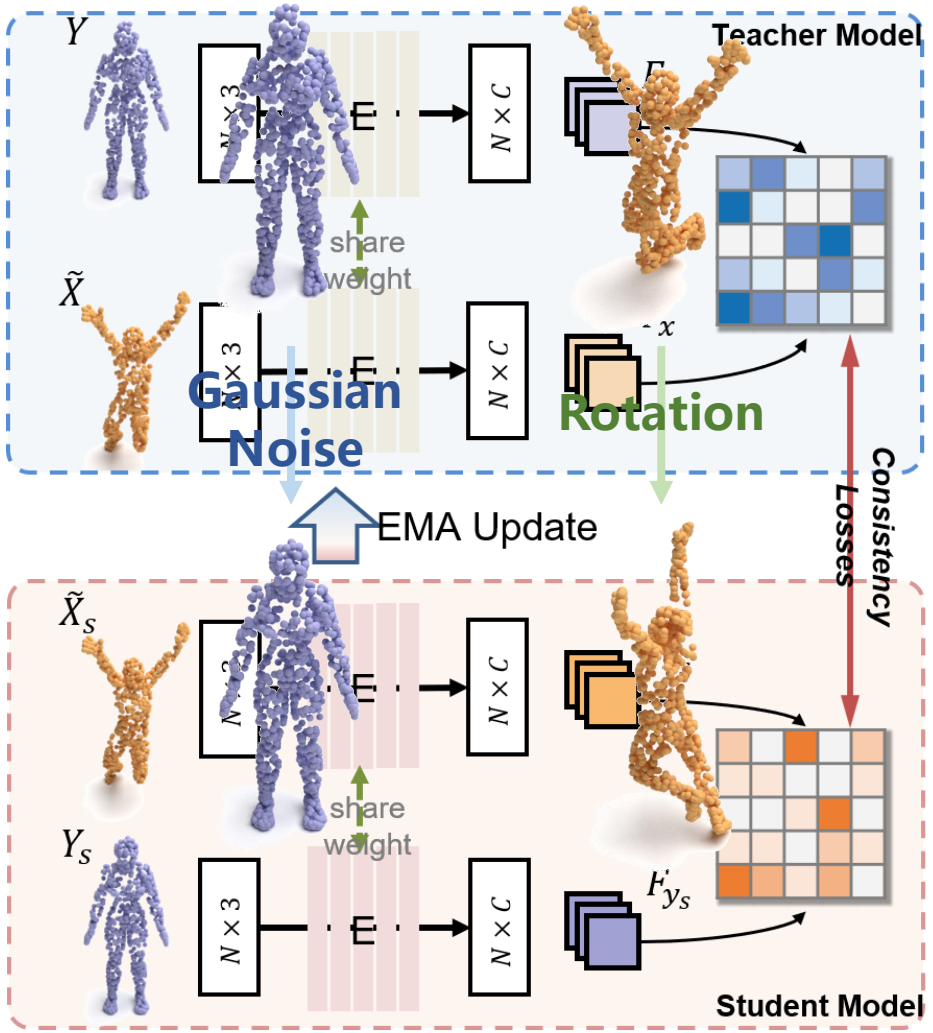
☐ Teacher & Student Models

Our approach follows ***the Mean Teacher paradigm*** and inputs the aligned point cloud pairs into the student and teacher models.



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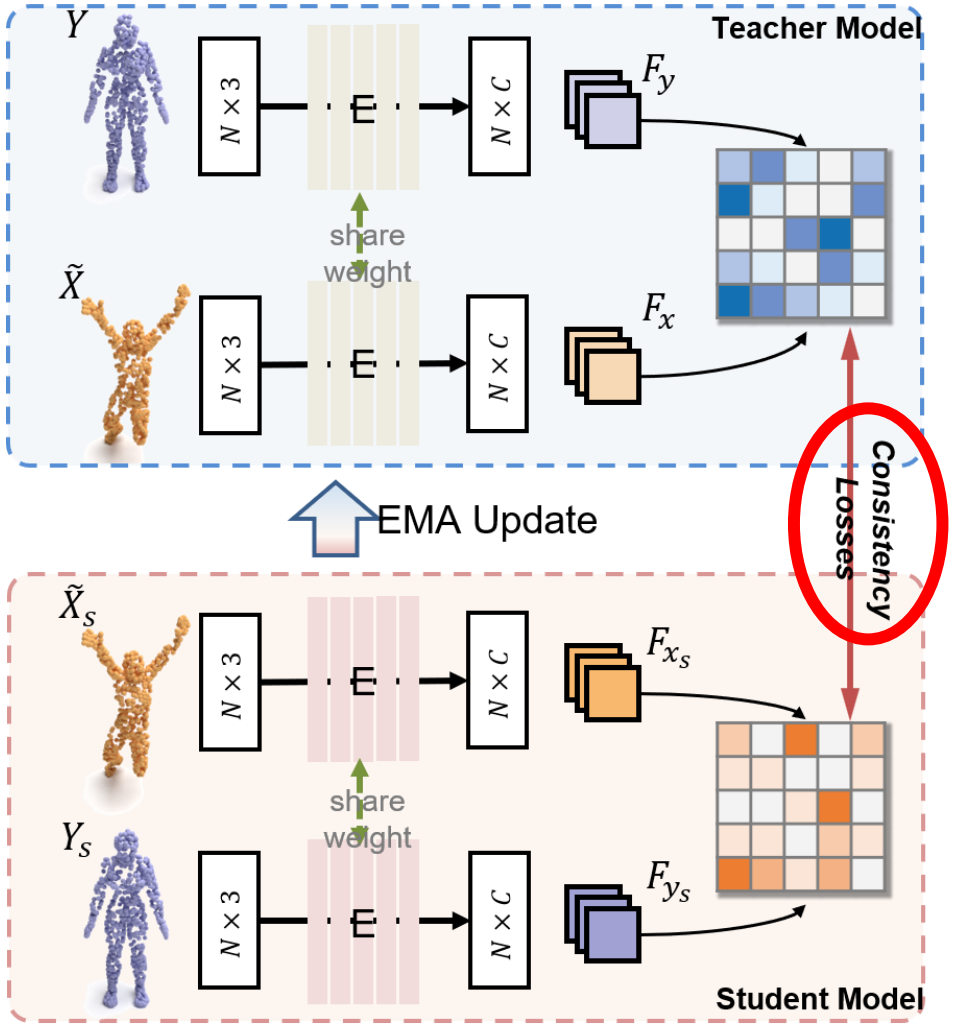
☐ Soft label

We take the output of the teacher model as ***soft labels*** and design two ***consistency losses***.



Qualitative Results

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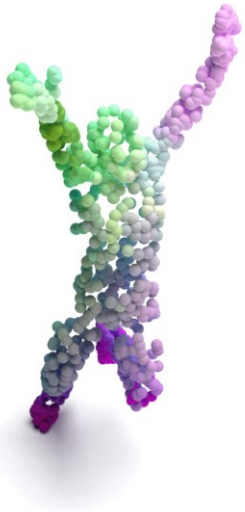
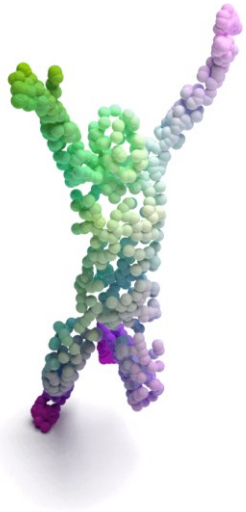
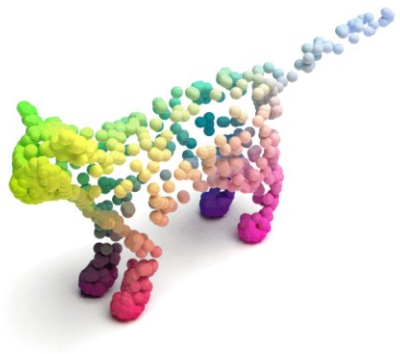
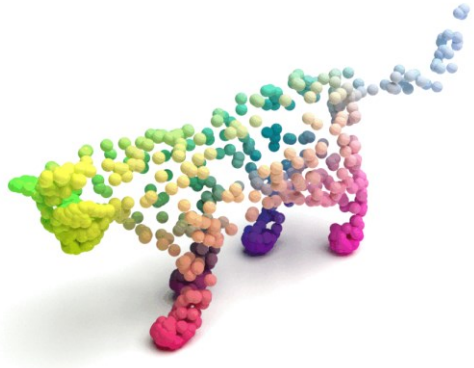
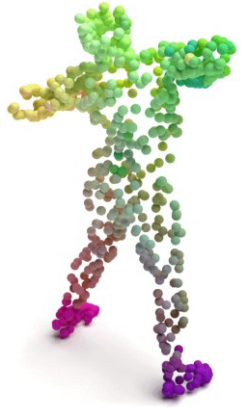
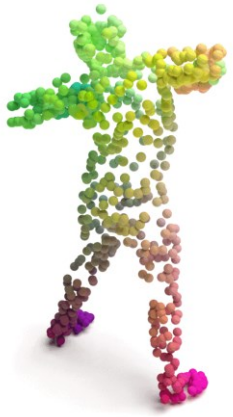
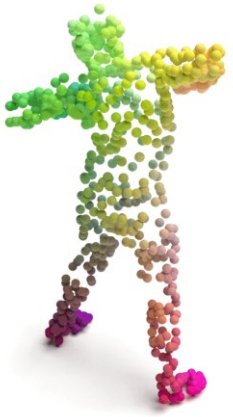





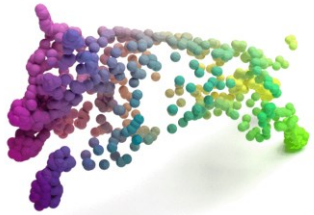

Source

Target

GT

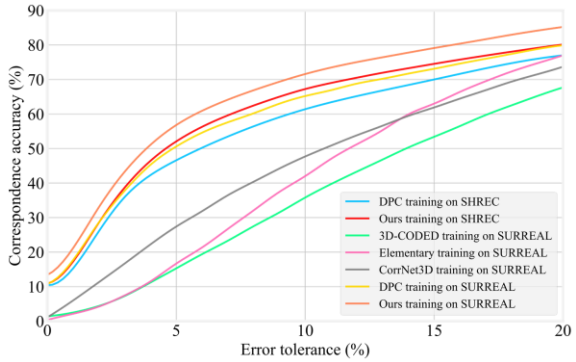
Comparison

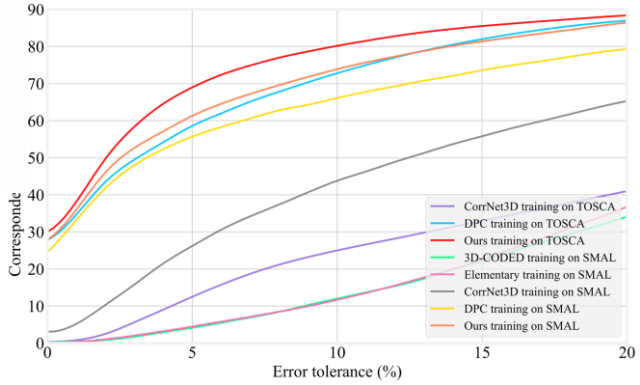



Source DPC Ours GT

Method	Input	SHREC		SURREAL	
		acc ↑	err ↓	acc ↑	err ↓
Diff-FMaps [16]	Point	/	/	4.0%	7.1
3D-CODED [8]	Point	/	/	2.1%	8.1
Elementary [4]	Point	/	/	2.3%	7.6
CorrNet3D [32]	Point	0.4%	33.8	6.0%	6.9
DPC [12]	Point	15.3%	5.6	17.7%	6.1
Ours	Point	**17.5%**	**5.1**	**21.5%**	**4.6**



Method	TOSCA		SMAL	
	acc ↑	err ↓	acc ↑	err ↓
3D-CODED [8]	/	/	0.5%	19.2
Elementary [4]	/	/	0.5%	13.7
CorrNet3D [32]	0.3%	32.7	5.3%	9.8
DPC [12]	34.7%	2.8	33.2%	5.8
Ours	**38.2%**	**2.7**	**36.4%**	**3.9**



Conclusion

- We design a **lightweight** Orientation Estimation Module to align the orientations of point cloud pairs for accurate matching *symmetrical parts*.
- We unify orientation modeling, point cloud representation and *noise disturbance* into a **self-ensembling** framework.
- **SE-ORNet** attains **state-of-the-art** performance on both *human* and *animal* benchmarks.

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Thanks for watching!

paper

code

website