ComputerVisionLab
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JUNE 18-22, 2023
CVPR
VANCOUVER, CANADA

WED-AM-115

ACL-SPC: Adaptive Closed-Loop system for Self-Supervised Point Cloud Completion




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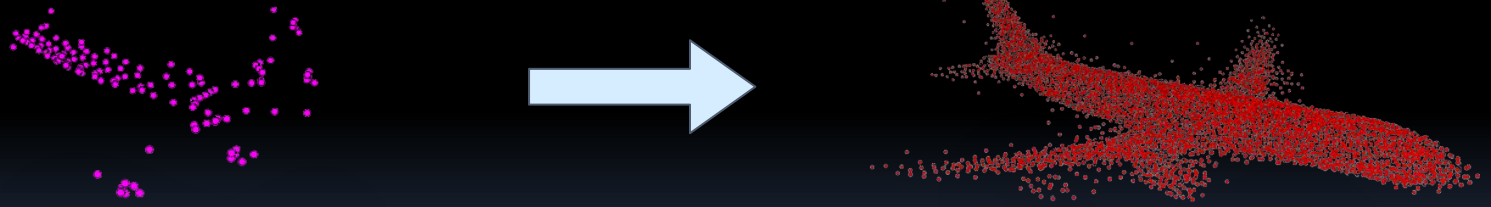
SCAN ME

Point Cloud Completion

- **Partial point cloud:** Point clouds obtained from a real-world sensor or multiview images.
- **Point cloud completion:** Completing missing parts of 3D shapes from a partial point cloud.



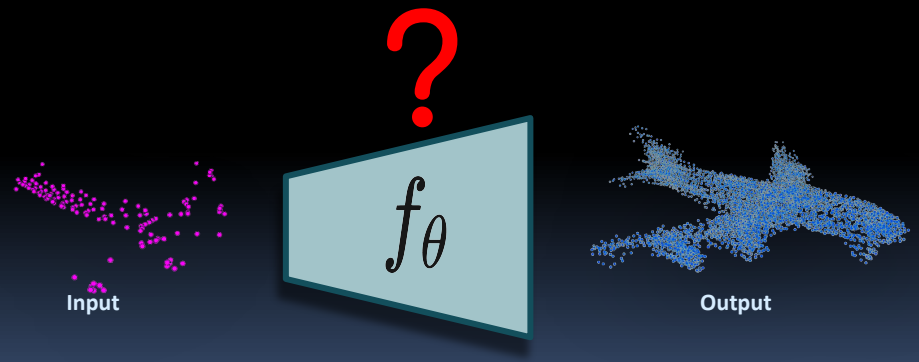
Partial Point Cloud P

Complete Point Cloud C

Motivations

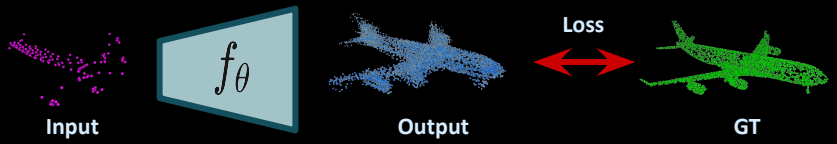
- Collecting paired/unpaired data or multiple partial view are difficult in practice for real-world applications.

- We propose ACL-SPC, the first self-supervised framework, for point cloud completion.



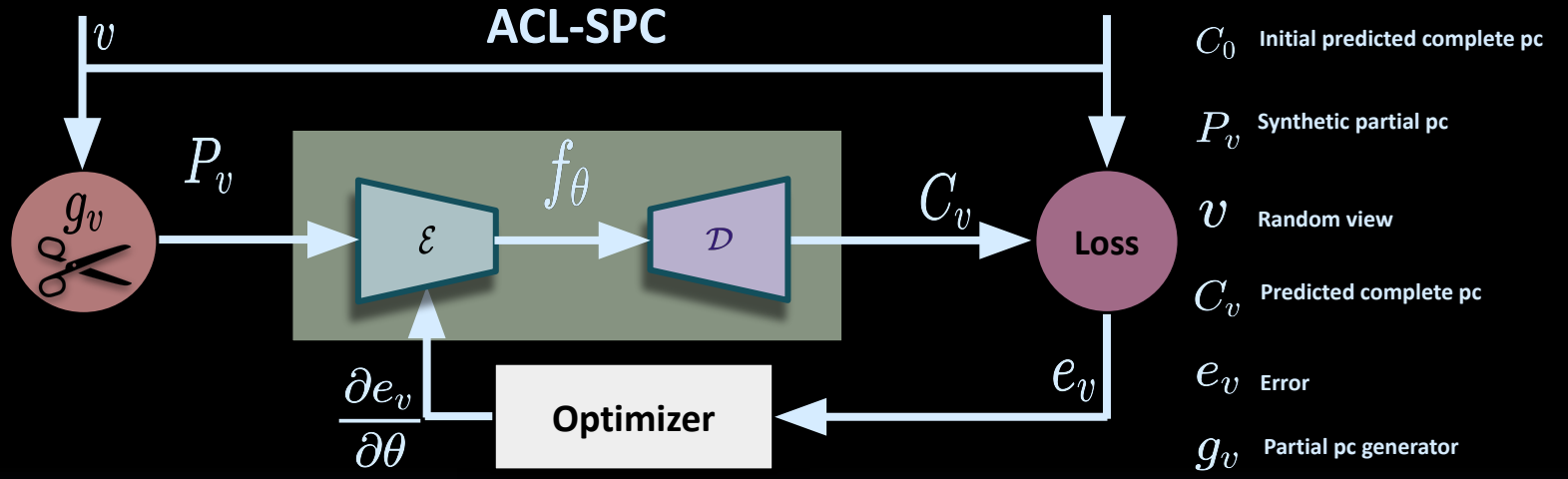
Previous Methods

- **Supervised Point Cloud Completion:**
  - Training the model by reducing the reconstruction loss between the generated point cloud and ground truth.



- **Unsupervised Point Cloud Completion:**
  - Weakly supervised methods utilize multiple partial views of object as supervision.
  - Attempts to utilize unpaired complete point clouds.

Overview of ACL-SPC



- **Adaptive closed-loop (ACL):** A system where a controller automatically gives compensated signal for the variations in the system.

Framework of ACL-SPC

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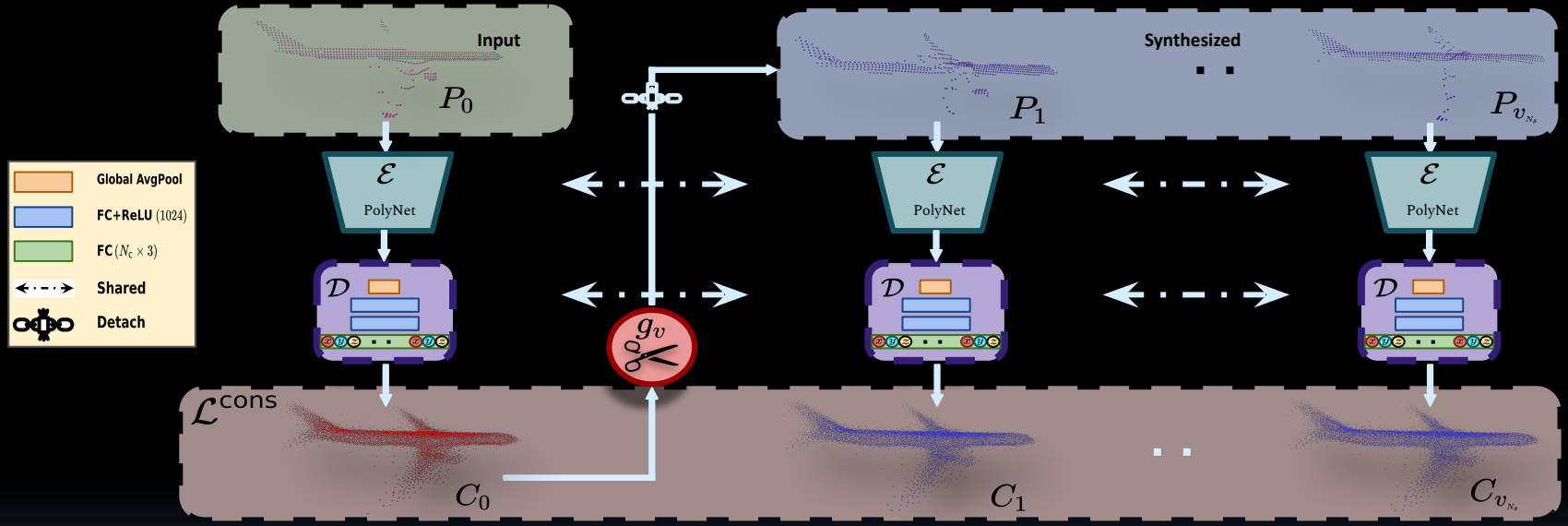

Self-Supervised Loss (1)

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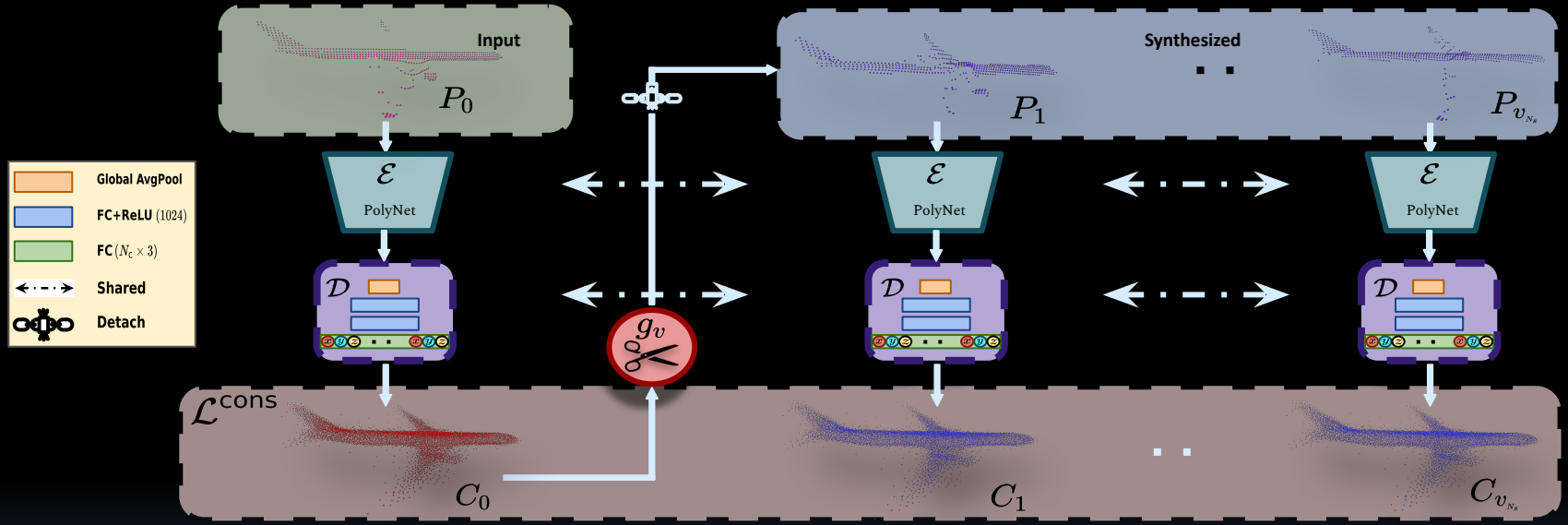
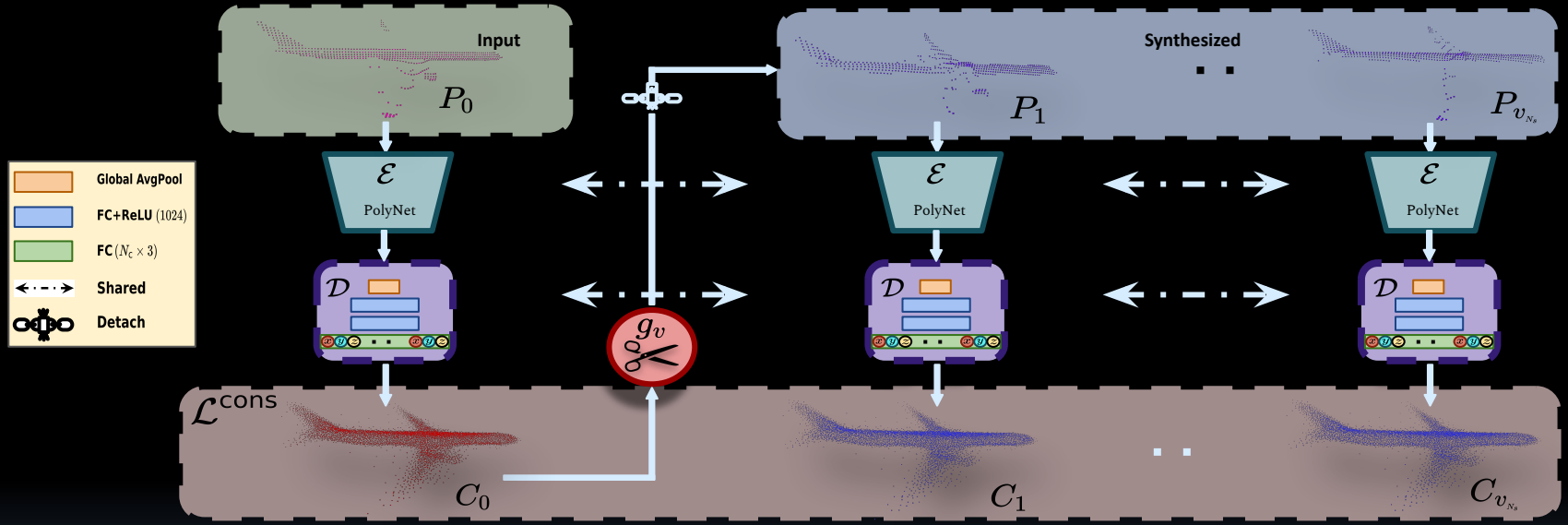


- Weighted Chamfer distance between the input and output.

$$\mathcal{L}^{\text{wcd}} = \frac{\alpha}{N_c} \sum_{p \in C_0} \min_{q \in P_0} ||p - q||_2 + \frac{\beta}{N_p} \sum_{q \in P_0} \min_{p \in C_0} ||q - p||_2$$

Self-Supervised Loss (2)



- Consistency loss between the regenerated complete point cloud and the initially generated one.

$$\mathcal{L}^{\text{cons}} = \frac{1}{N_c \times N_s} \sum_{v \in \{v_i\}_{i=1}^{N_s}} ||C_v - C_0||_2^2,$$

Experiment on synthetic dataset

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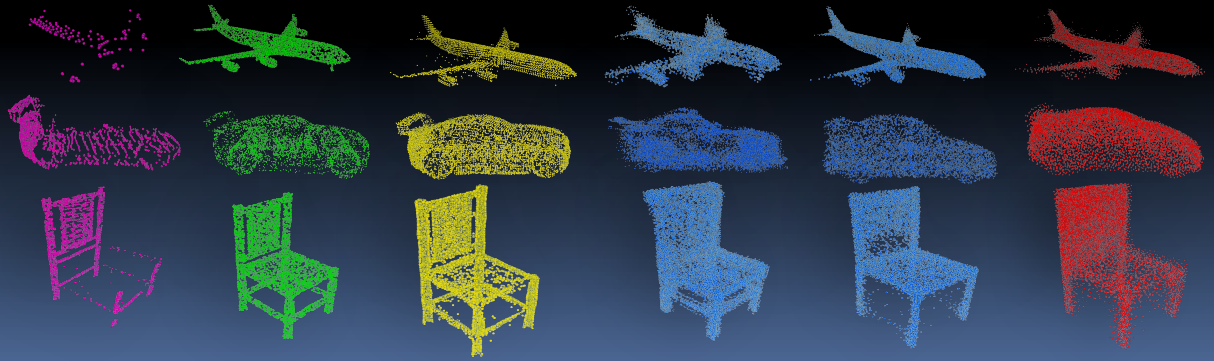
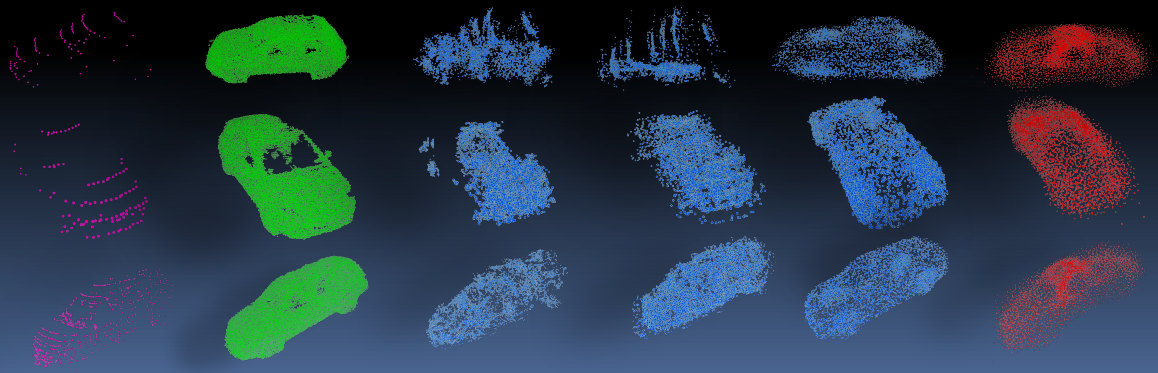
Supervision	Method	Airplane			Car			Chair		
		P↓	C↓	CD↓	P↓	C↓	CD↓	P↓	C↓	CD↓
Unsupervised	DPC [16]	-	-	3.91	-	-	3.47	-	-	4.30
	Gu *et al.* [15]	**0.91**	1.05	**1.95**	1.27	1.41	**2.68**	**1.69**	1.64	**3.33**
	PointPnCNet [21]	1.58	1.74	3.32	**1.08**	2.08	4.96	2.72	2.68	5.40
Self-supervised	Ours	1.20	**0.80**	2.01	1.65	**1.28**	2.93	2.25	**1.46**	3.71



(a) Input (b) GT (c) Multi-View (d) GRNet [43] (e) Gu *et al.* [15] (f) Ours

Experiment on real-world dataset

Supervision	Method	P↓	C↓	CD↓
Supervised	GRNet [43]	**4.63**	6.90	**11.53**
	SFNet [42]	14.12	12.64	26.76
	Pcn [49]	9.83	17.96	27.79
Unsupervised	Gu *et al.* [15]	8.70	10.70	19.40
	PointPnCNet [21]	9.00	10.00	19.00
Self-supervised	Ours	11.67	**5.63**	17.30



Conclusion

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- We propose ACL-SPC, the first self-supervised point cloud completion method from only a single input partial point cloud.

- Through experiments, we show that our method can be more useful in real-world scenarios without performance degradation.

- One limitation is that there is no constraint for redundant points.

Thank you

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