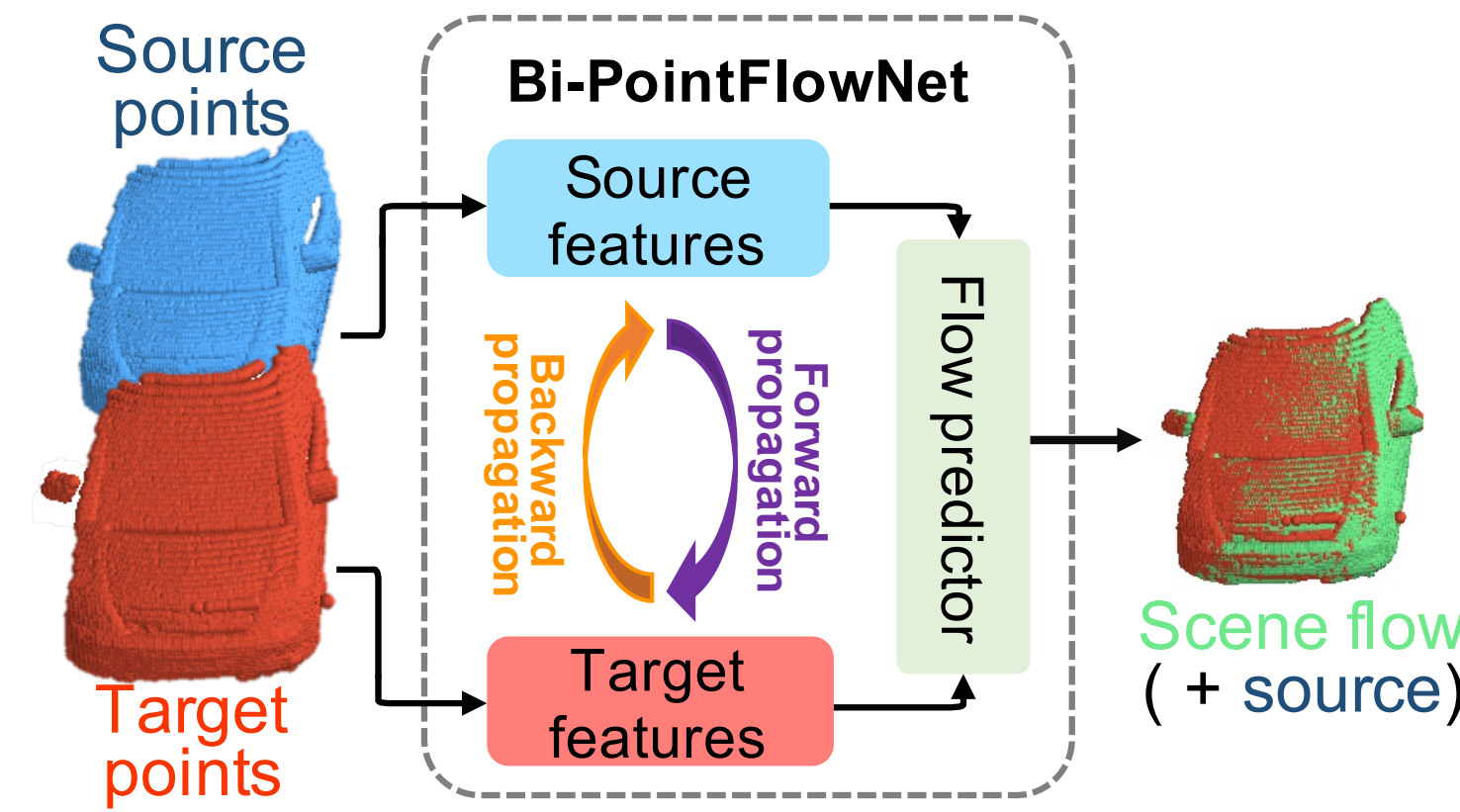


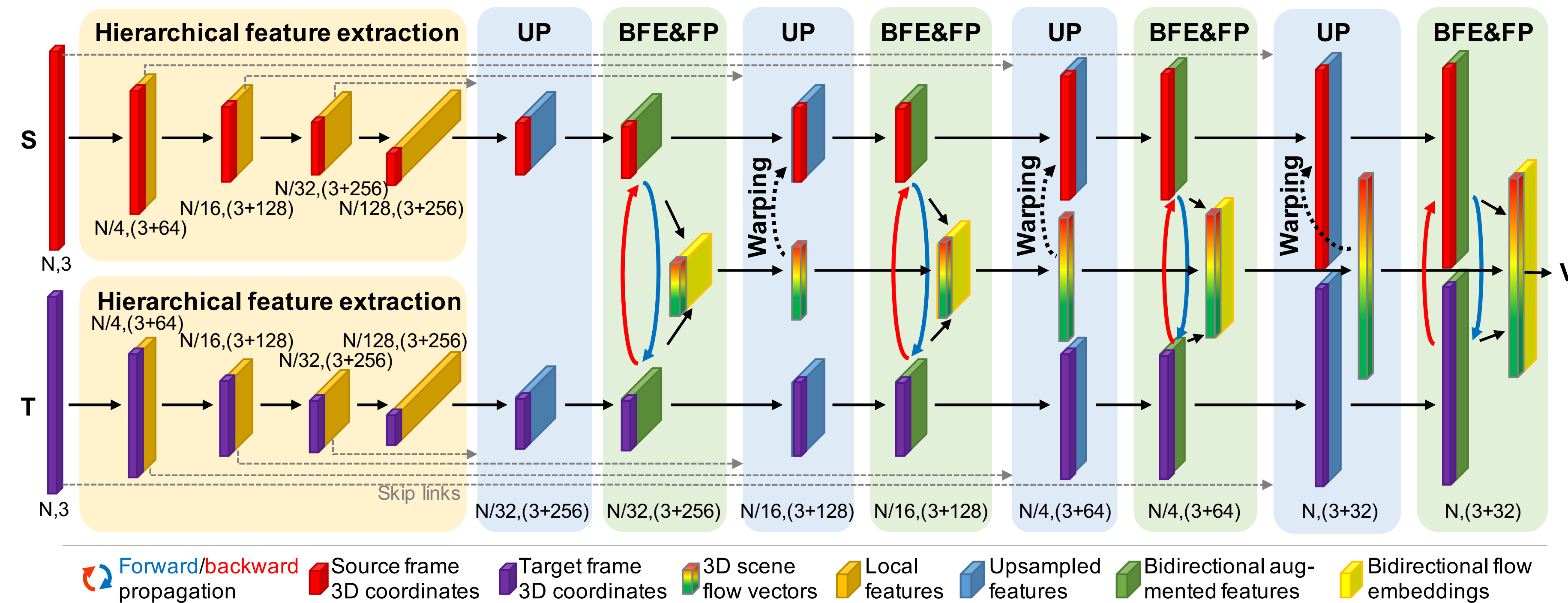
Task and Motivation

- Task:** estimate a 3D point-wise motion field in a dynamic scene
- Motivation:** the task is in fact a temporal sequence processing that can benefit from the bidirectional learning used in the NLP models
- Our method:** Bi-PointFlowNet extracts bidirectional correlations that significantly improve flow estimation performance



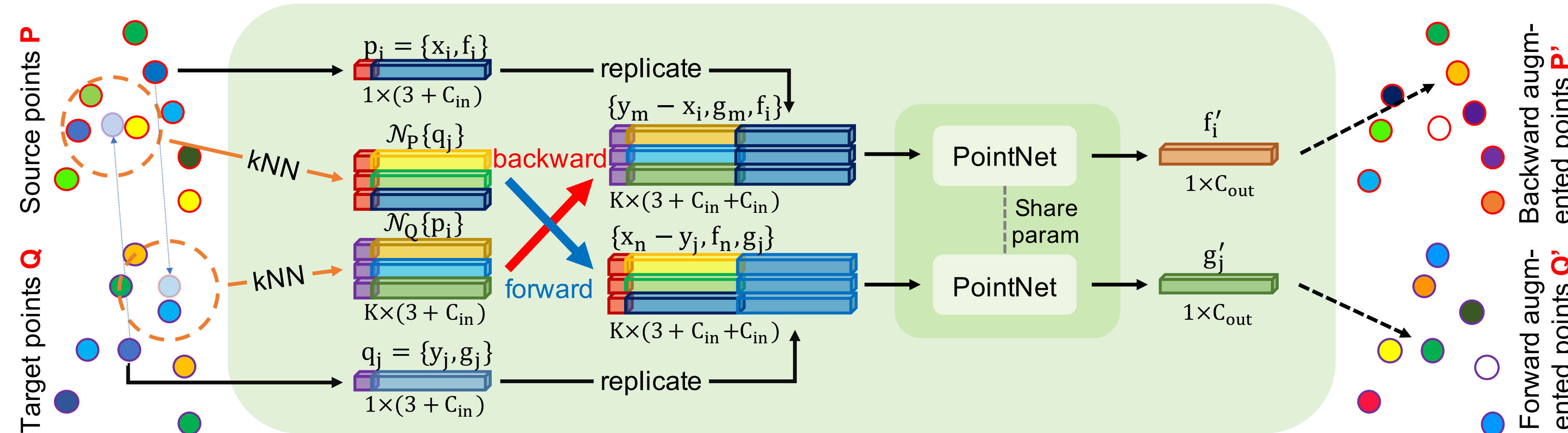
Method and Approach

Architecture of Bi-PointFlowNet



- Bi-PointFlowNet follows the coarse-to-fine design for an accurate estimation
- Bi-PointFlowNet introduces a bidirectional flow embedding (BFE) layer consisting of a bidirectional flow propagation and a conventional flow embedding layer for the correlation extraction

Bidirectional Flow Propagation (BFP)



- The source and target points are propagated bidirectionally for the robust correlation extraction
- Redundant computations of the replicated feature are further optimized by a decomposed form

Experimental results

Easy mode (No occlusion)

→ EPE3D outperformed SOTA by 38% and 45%

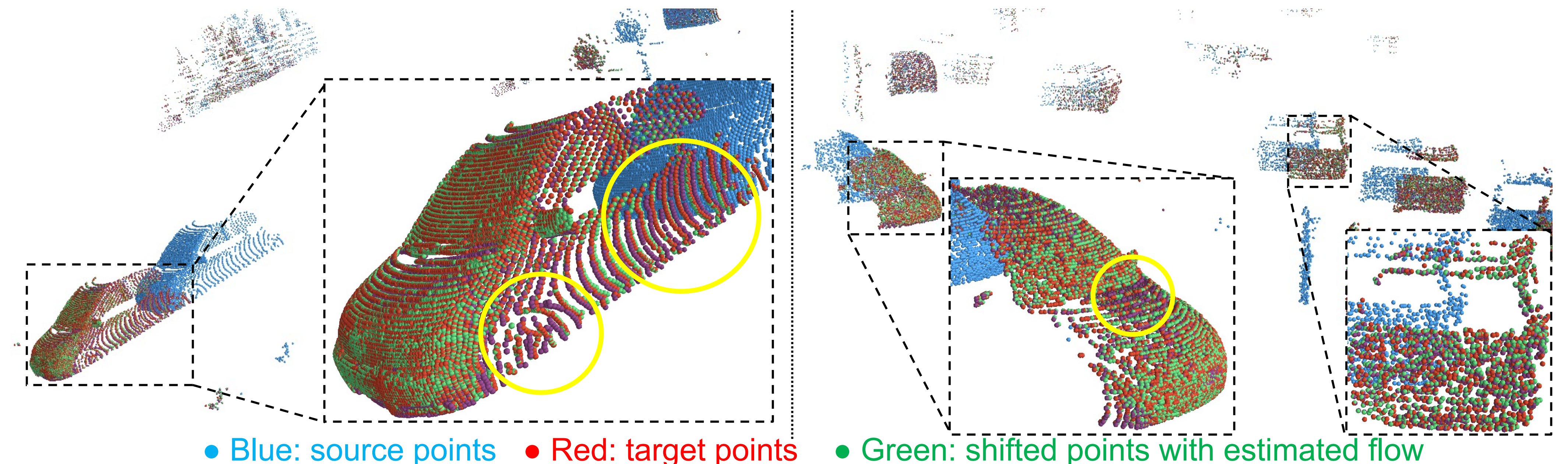
Dataset	Method	EPE3D (m) ↓	ACC3D S ↑	ACC3D R ↑	Outliers 3D ↓
FT3D _s	FlowNet3D [21]	0.113	0.412	0.771	0.602
	HPLFlowNet [9]	0.080	0.614	0.855	0.429
	PointPWC [45]	0.059	0.738	0.928	0.342
	FLOT [30]	0.052	0.732	0.927	0.357
	HCRF-Flow [19]	0.048	0.835	0.950	0.261
	FlowStep3D [16]	0.045	0.816	0.961	0.216
	Ours	0.028	0.918	0.978	0.143
KITTI _s	FlowNet3D [21]	0.177	0.374	0.668	0.527
	HPLFlowNet [9]	0.117	0.478	0.778	0.410
	PointPWC [45]	0.069	0.728	0.888	0.265
	FLOT [30]	0.056	0.755	0.908	0.242
	HCRF-Flow [19]	0.053	0.863	0.944	0.179
	FlowStep3D [16]	0.054	0.805	0.925	0.149
	Ours	0.030	0.920	0.960	0.141

Ablation experiments

→ Bidirectional learning outperforms significantly

Dataset	BFP	EPE3D (m) ↓	ACC3D S ↑	ACC3D R ↑	Outliers 3D ↓	EPE2D (px) ↓	ACC 2D ↑
FT3D _s	×	0.042	0.836	0.962	0.263	2.270	0.882
	✓	0.028	0.918	0.978	0.143	1.582	0.929
KITTI _s	×	0.053	0.858	0.930	0.194	1.894	0.880
	✓	0.030	0.920	0.960	0.141	1.056	0.949

Qualitative results



Conclusion

- First introduced **bidirectional learning** for point cloud based scene flow estimation
- Implemented an **efficient bidirectional** architecture
- Proposed novel layers for **bidirectional flow embedding** generation
- Optimized the novel bidirectional architecture in terms of efficiency
- State-of-the-art** in scene flow estimation using point cloud input
- Requiring the **lowest** computational overhead

