Multi-View Stereo Representation Revisit: Region-Aware MVSNet

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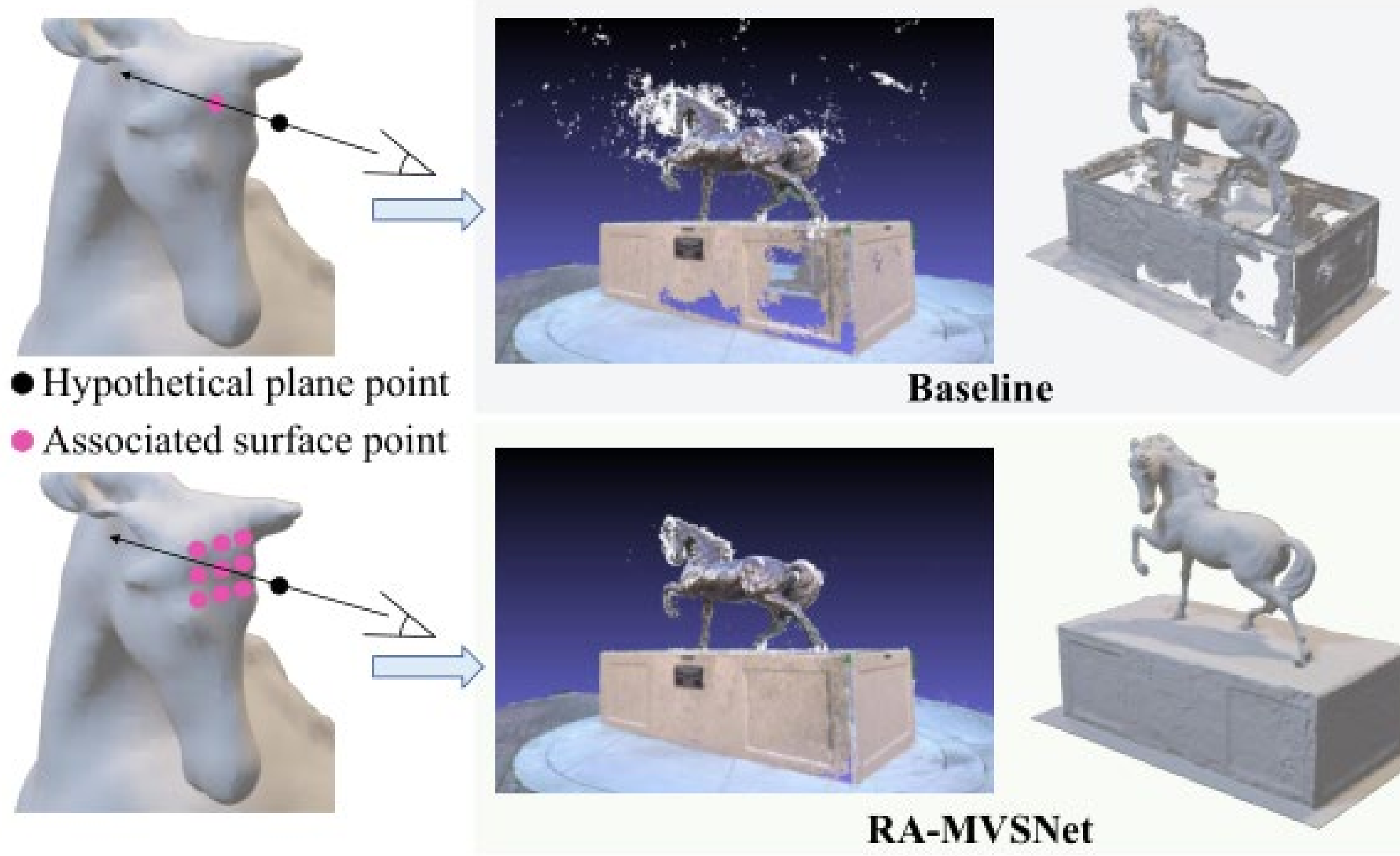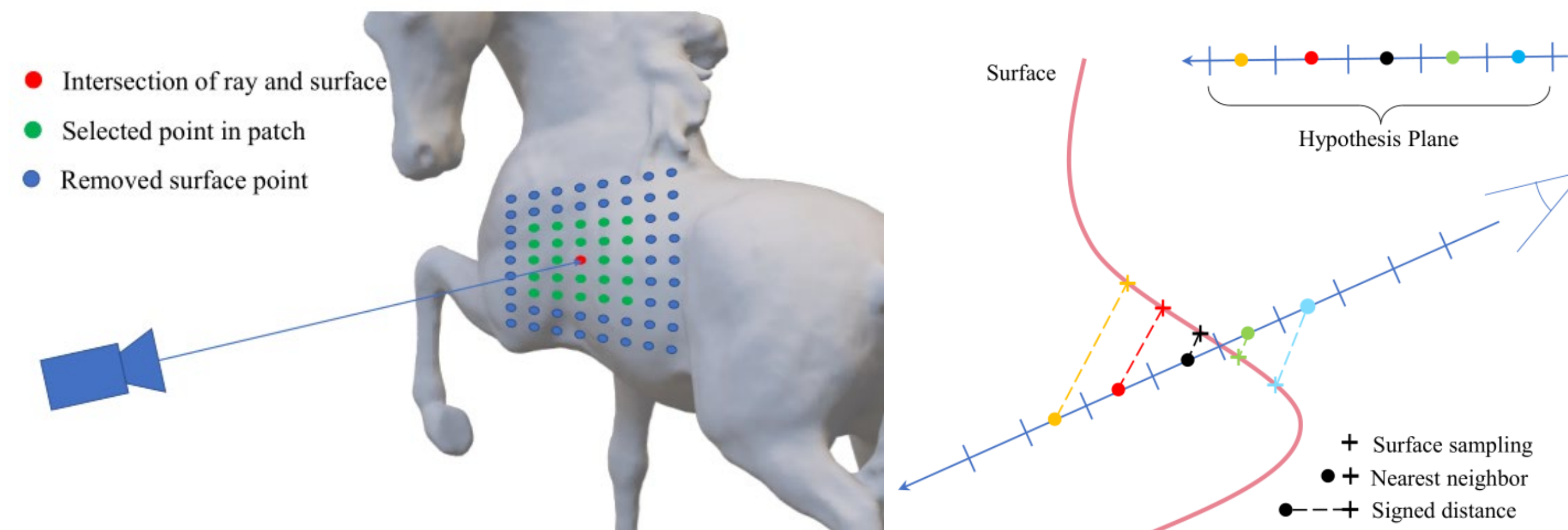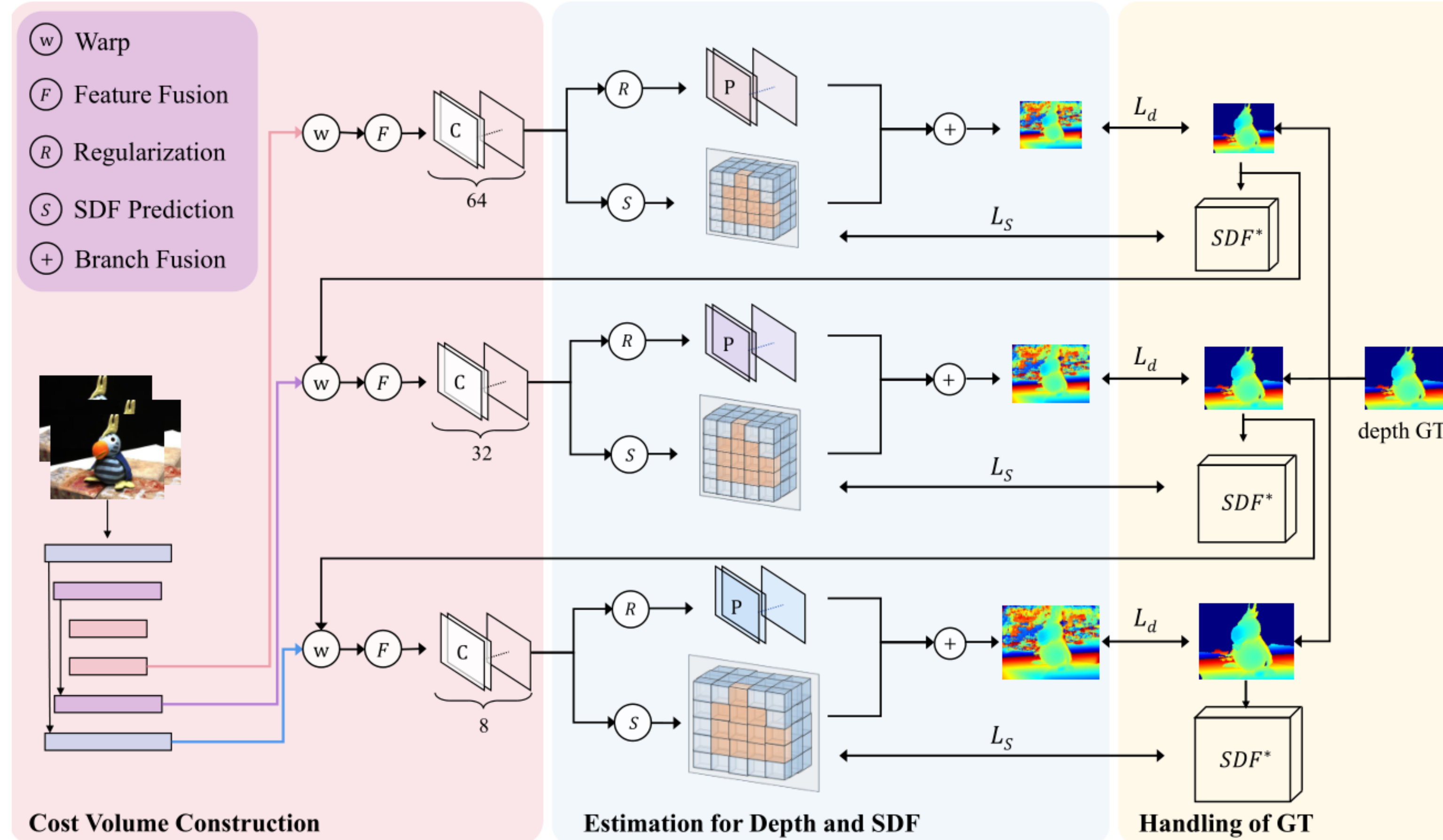
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CVPR VANCOUVER, CANADA

Motivation

➤ Most of the existing approaches only estimate the pixel-wise depth value by minimizing the gap between the predicted point and the intersection of ray and surface, which usually ignore the surface topology.

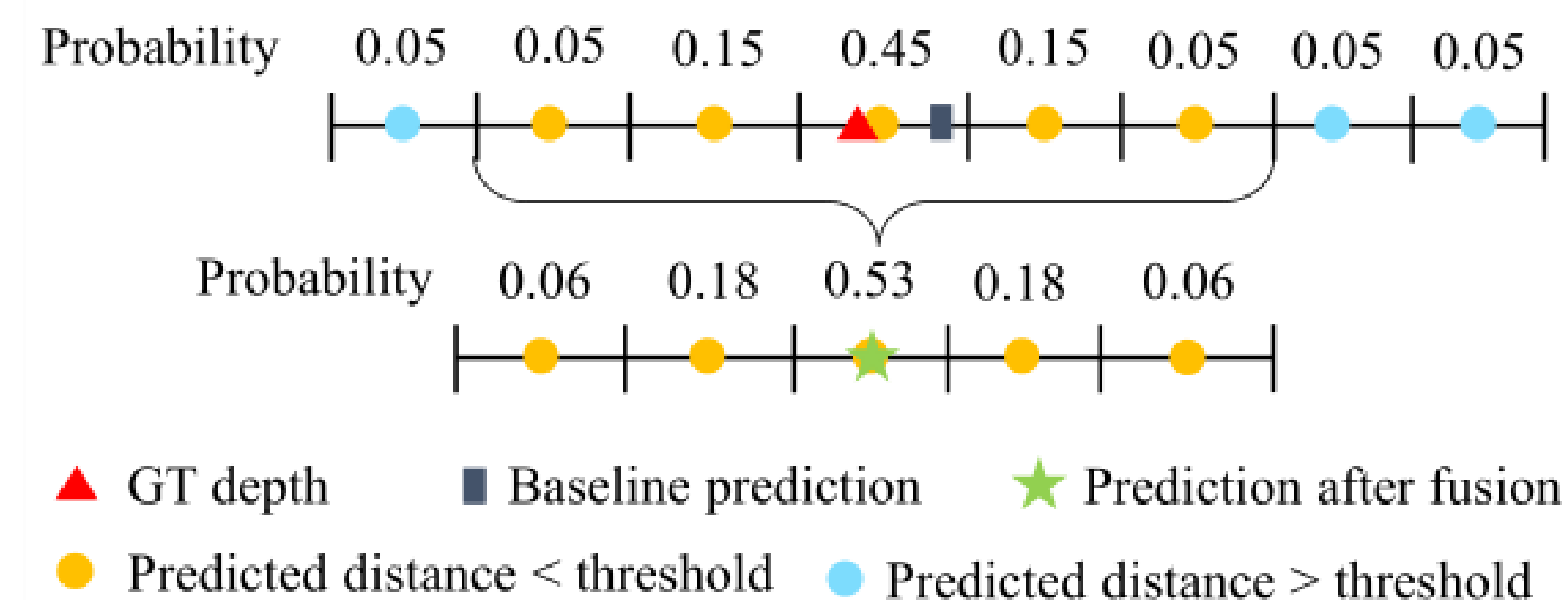➤ Patch-awared could benefit textureless regions and surface boundary

● Hypothetical plane point
● Associated surface point

Baseline

RA-MVSNet

Patch-based nearest neighbor

● Intersection of ray and surface
● Selected point in patch
● Removed surface point

Surface

Hypothesis Plane

+ Surface sampling
+ Nearest neighbor
--- Signed distance

Our RA-MVSNet Framework

Ⓦ Warp
Ⓕ Feature Fusion
Ⓡ Regularization
Ⓢ SDF Prediction
⊕ Branch Fusion

Cost Volume Construction | Estimation for Depth and SDF | Handling of GT

➤ Introduce point-to-surface distance supervision of sampled points to expand the perception range predicted by the model, which achieves complete estimation in textureless areas and reduce outliers in object boundary regions.

➤ Compute the signed distance between point sets based on the triangulated mesh, which trades off between accuracy and speed.

Probability 0.05 0.05 0.15 0.45 0.15 0.05 0.05 0.05

Probability 0.06 0.18 0.53 0.18 0.06

▲ GT depth   ▨ Baseline prediction   ★ Prediction after fusion
● Predicted distance < threshold   ● Predicted distance > threshold

Volume fusion

➤ How to make predictions more accurate.

Results

➤ F-score on Tanks and Temples benchmark

Method	Intermediate									Advanced						
	Mean	Fam.	Fra.	Hor.	Lig.	M60	Pan.	Pla.	Tra.	Mean	Aud.	Bal.	Cou.	Mus.	Pal.	Tem.
MVSNet [40]	43.48	55.99	28.55	25.07	50.79	53.96	50.86	47.90	34.69	-	-	-	-	-	-	-
Point-MVSNet	48.27	61.79	41.15	34.20	50.79	51.97	50.85	52.38	43.06	-	-	-	-	-	-	-
CVP-MVSNet [38]	54.03	76.50	47.74	36.34	55.12	57.28	54.28	57.43	47.54	-	-	-	-	-	-	-
P-MVSNet [5]	55.62	70.04	44.64	40.22	65.20	55.08	55.17	60.37	54.29	-	-	-	-	-	-	-
D^2HC-RMVSNet [37]	59.20	74.69	56.04	49.42	60.08	59.81	59.61	60.04	53.92	-	-	-	-	-	-	-
RayMVSNet [33]	59.48	78.55	61.93	45.48	57.59	61.00	59.78	59.19	52.32	-	-	-	-	-	-	-
PatchmatchNet [31]	53.15	66.99	52.64	43.24	54.87	52.87	49.54	54.21	50.81	32.31	23.69	37.73	30.04	41.80	28.31	32.29
CasMVSNet [13]	56.84	76.37	58.45	46.26	55.81	56.11	54.06	58.18	49.51	31.12	19.81	38.46	29.10	43.87	27.36	28.11
AA-RMVSNet [32]	61.51	77.77	59.53	51.53	64.02	64.05	59.47	60.85	55.50	33.53	20.96	40.15	32.05	46.01	29.28	32.71
GBi-Net [23]	61.42	79.77	67.69	51.81	61.25	60.37	55.87	60.67	53.89	37.32	29.77	42.41	36.30	47.69	31.11	36.93
EPP-MVSNet [22]	61.68	77.86	60.54	52.96	62.33	61.69	60.34	62.44	55.30	35.72	21.28	39.74	35.34	49.21	30.00	38.75
TransMVSNet [8]	63.52	80.92	65.83	56.94	62.54	63.06	60.00	60.20	58.67	37.00	24.84	44.59	34.77	46.49	34.69	36.62
Uni-MVSNet [25]	64.36	81.20	66.43	53.11	63.46	66.09	64.84	62.23	57.53	38.96	28.33	44.36	39.74	52.89	33.80	34.63
RA-MVSNet (ours)	65.72	82.44	66.61	58.40	64.78	67.14	65.60	62.74	58.08	39.93	29.17	46.05	40.23	53.22	34.62	36.30

➤ Results on DTU

Method	ACC.(mm) ↓	Comp.(mm) ↓	Overall(mm) ↓
Furu [11]	0.613	0.941	0.777
Gipuma [12]	0.283	0.873	0.578
COLMAP [27]	0.400	0.664	0.532
SurfaceNet [15]	0.450	1.040	0.745
MVSNet [40]	0.396	0.527	0.462
Point-MVSNet [4]	0.342	0.411	0.376
AA-RMVSNet [32]	0.376	0.339	0.357
CasMVSNet [13]	0.325	0.385	0.355
UCS-Net [6]	0.338	0.349	0.344
Uni-MVSNet [25]	0.352	0.278	0.315
TransMVSNet [8]	0.321	0.289	0.305
GBi-Net [23]	0.327	0.268	0.298
RA-MVSNet (ours)	0.326	0.268	0.297

■ Overall ● Memory

➤ Qualitative results on DTU

CasMVSNet   TransMVSNet   UniMVSNet   Ours
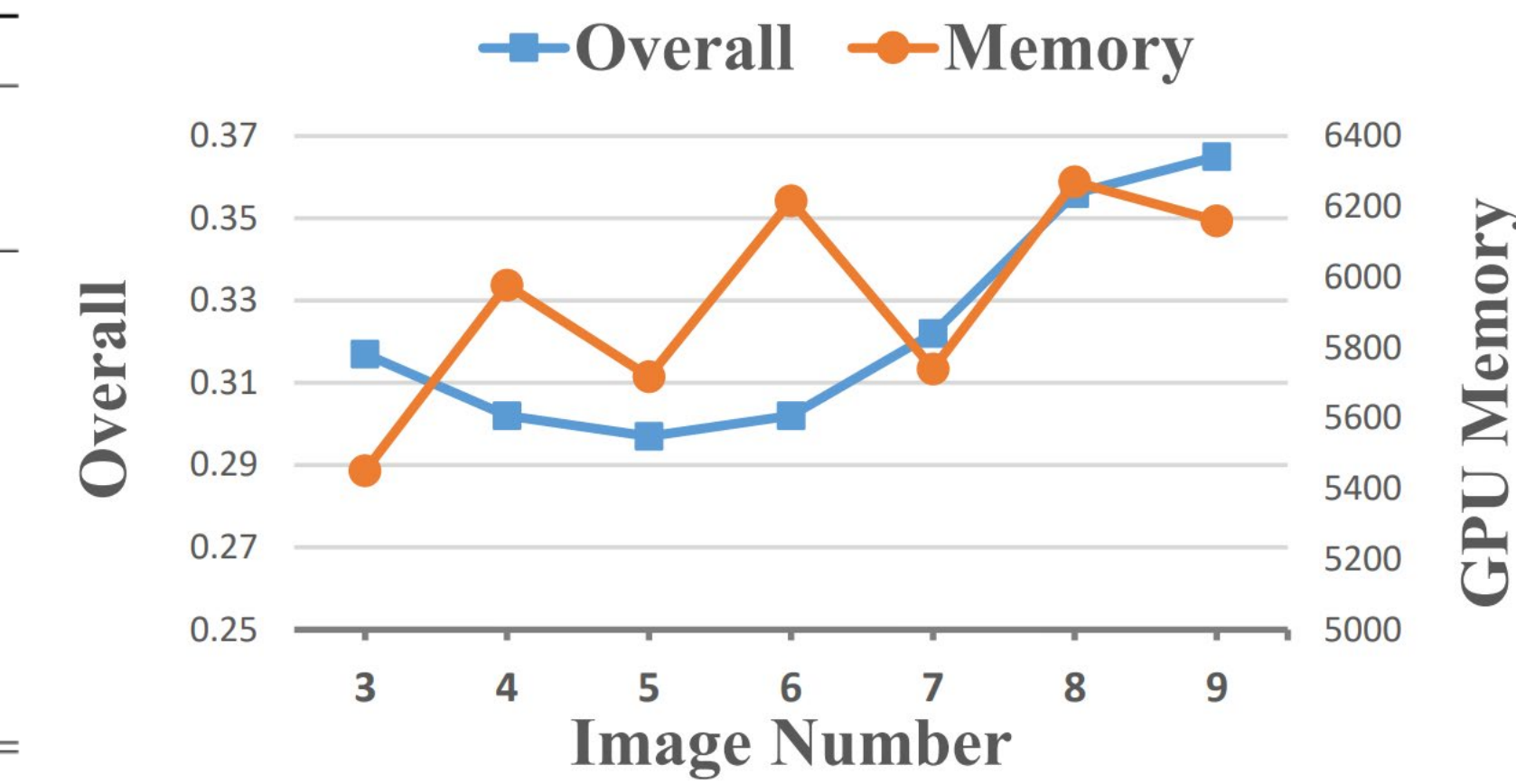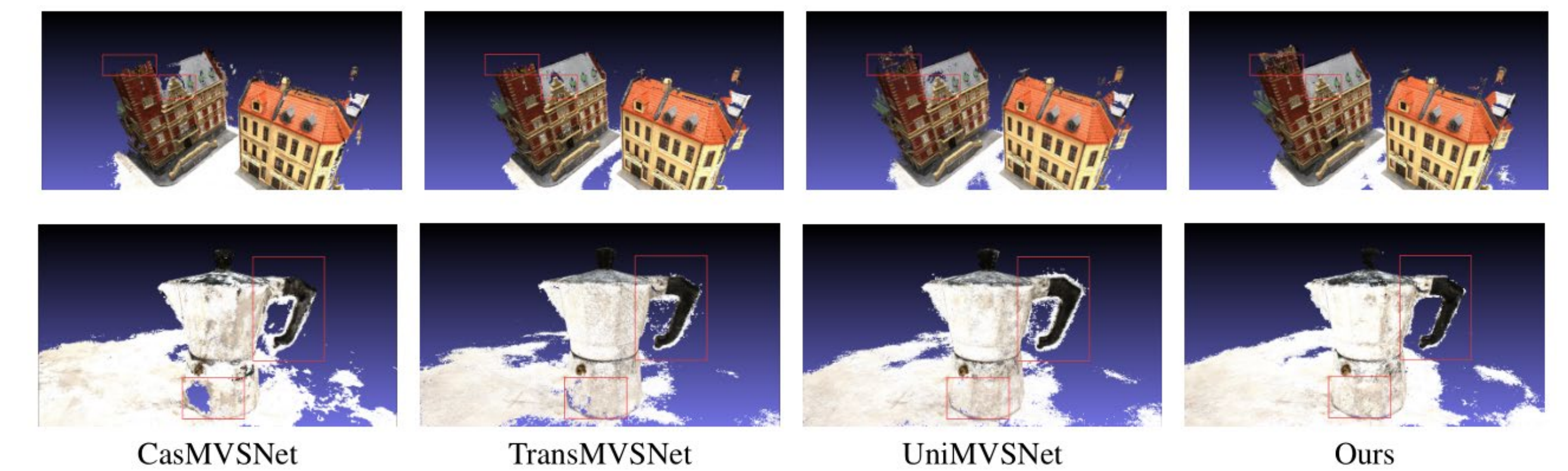
➤ Qualitative results on Tanks&Temples

Family   Panther   Museum   M60   Train   Playground