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AND Locate25
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Texture Reconstruction Method Guided by Multi-View Semantic Segmentation Information

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1 Research background

2 Method

3 Experiments and Analysis

4 Conclusions

Multiview reconstruction technology generates fine and realistic 3D models, which are widely used in large-scale mapping and 3D modeling.

Texture reconstruction plays a critical role in enhancing the realism of 3D models by generating detailed texture maps for geometric surfaces.

TRSP Framework Overview

Occlusion-aware scene construction

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3D Semantic Mapping

↓

Adaptive View Selection

↓

Two-Stage Color Blending

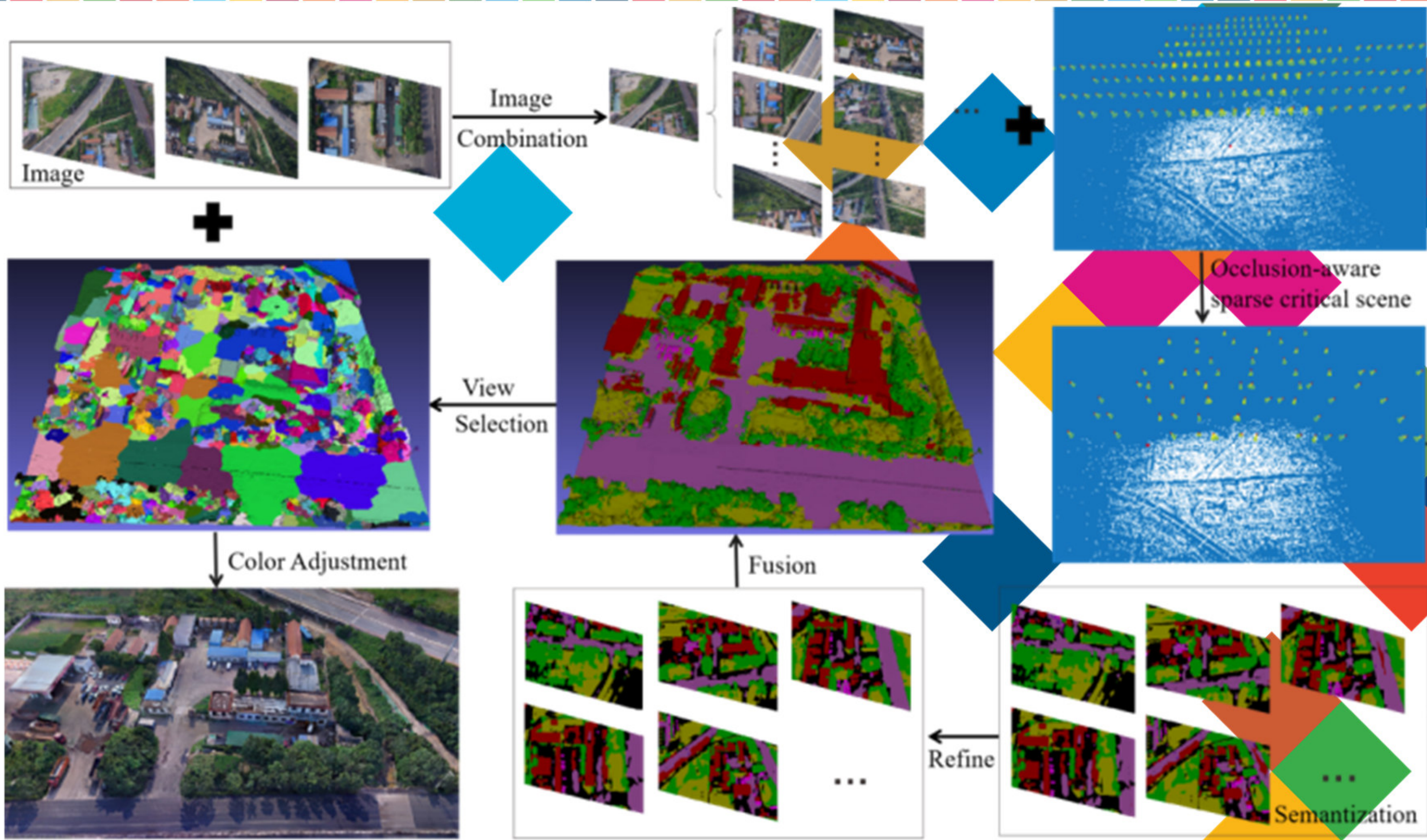


Fig. 2. Overview of the proposed algorithm

2.1 Occlusion-aware sparse critical scene construction

Key Factors :

- **Principal axis angle difference**
  – Determines optimal viewpoints for occlusion handling.
- **Feature overlap region**
  – Ensures sufficient texture detail preservation.
- **Number of common neighboring views**
  – Enhances robustness of view selection.

The multifactor joint normalized energy formula:

$$E_{weight}(i,j) = \alpha * Epi(i,j) + e^{\left(\gamma * \max\left(\frac{P_i}{area_i}, \frac{P_j}{area_j}\right) + \varphi * \frac{Com(i,j)}{\max(Match_{num})}\right)^{-1}}$$

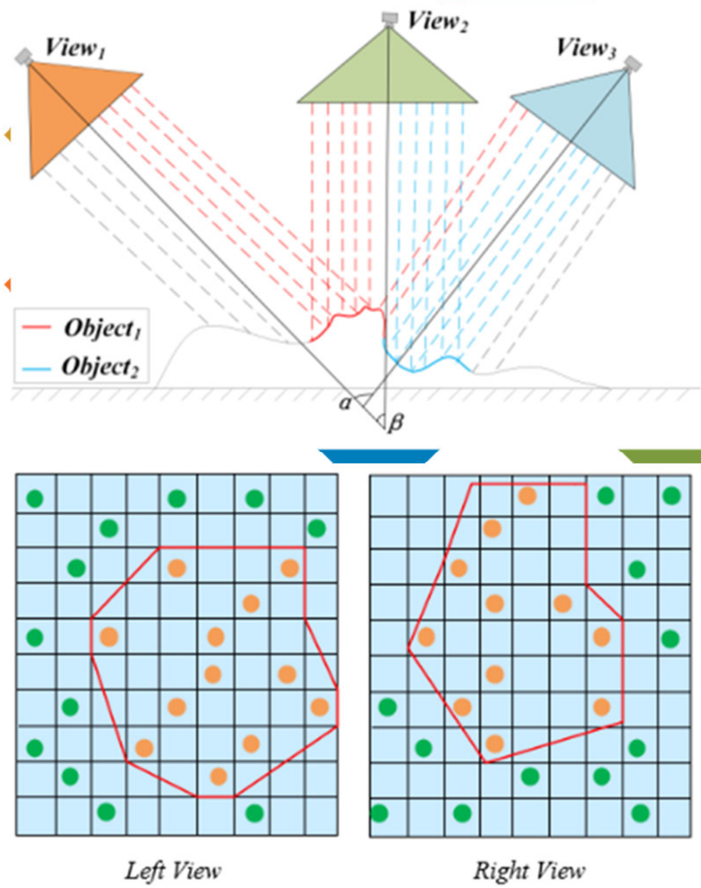
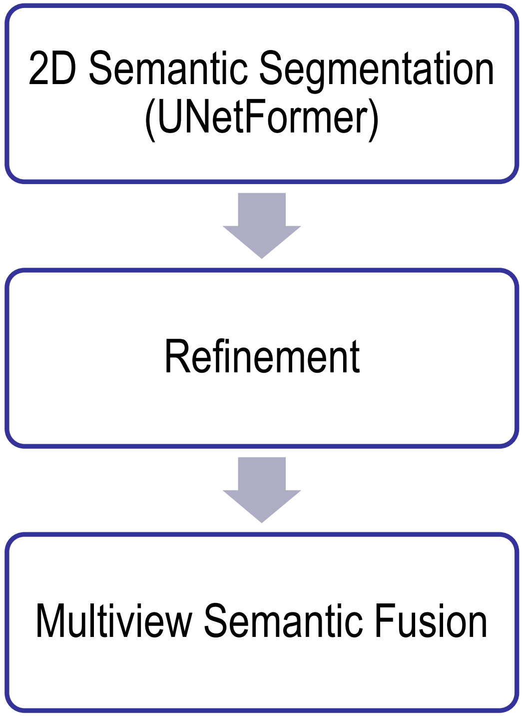


Fig. 3. Multiscale and multifactor joint screening

2.2 Consistency extraction of semantic information of 3D model



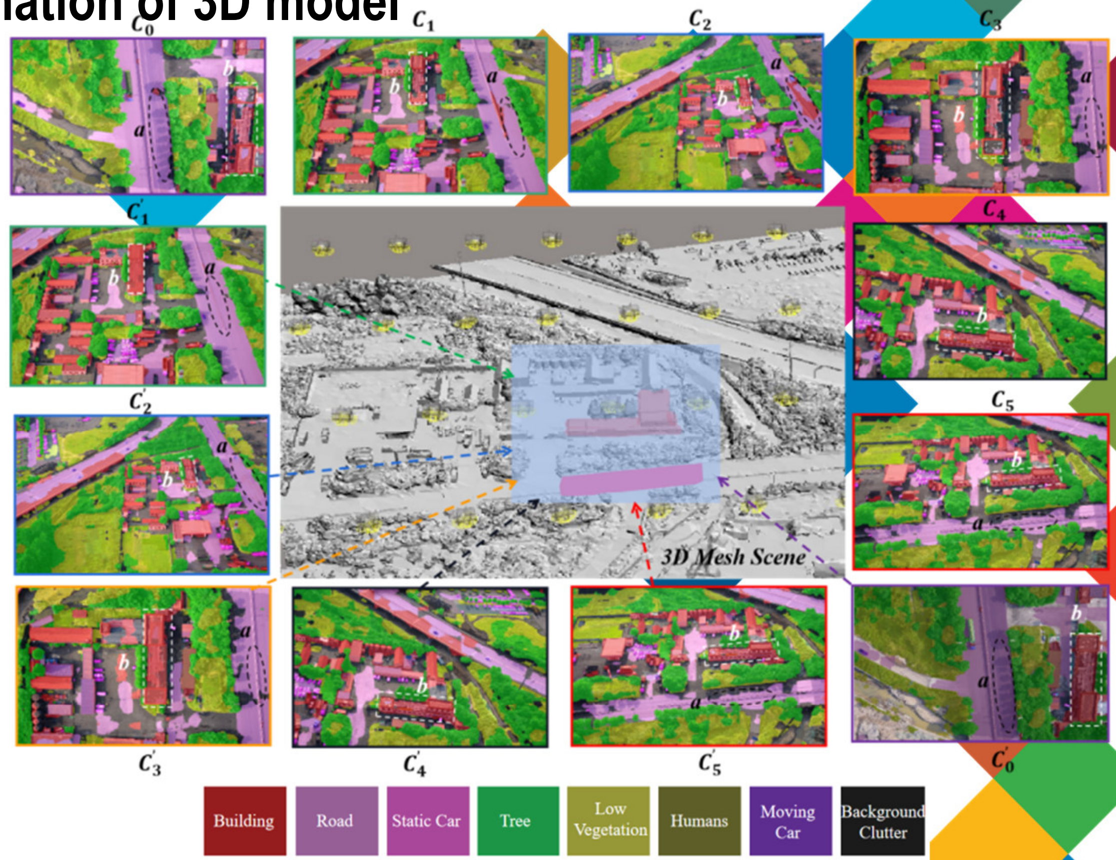


Fig. 4. Consistency extraction of semantic information from multiview images

2.3 View selection for prior knowledge of ground objects

For the first time, introducing the geometric structure characteristics of different types of ground objects into the energy function for the triangular face selection view.

The energy function of the prior knowledge of ground object categories is shown in formula:

$$Es(l) = \Phi * \sum_{F_i \in Faces} Es_{data}(f_i, l_i) + \Psi * \sum_{(F_i,F_j) \in Edges} Es_{smooth}(f_i, f_j, l_i, l_j, neig_i, neig_j)$$

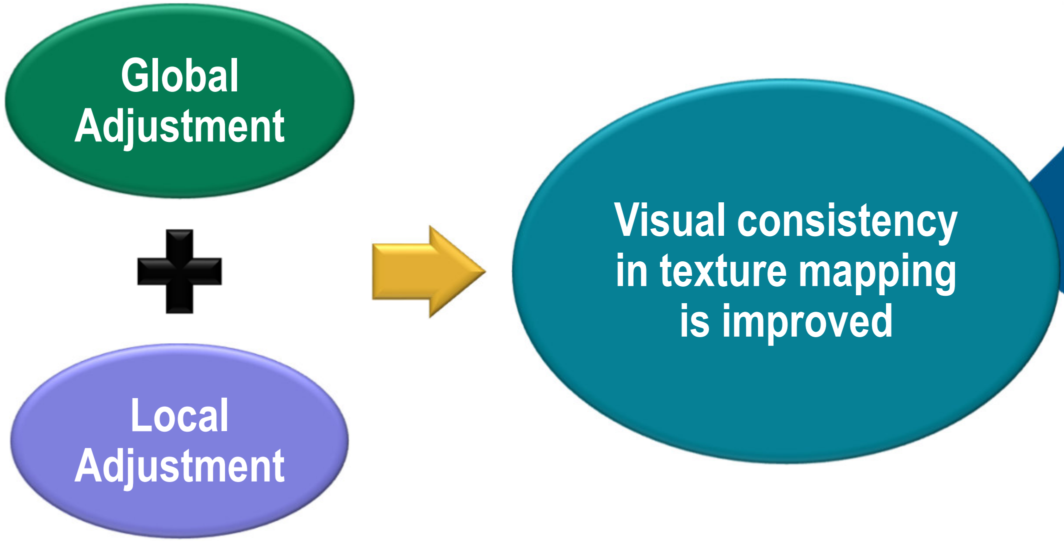
In addition, when the triangular face is a vegetation type, redefining the smoothing term to reduce the number of texture blocks:

$$Es_{smooth}(f_i, f_j, l_i, l_j, neig_i, neig_j) = \begin{cases} 0 & l_i = l_j \cap \alpha \leq A \\ \infty & l_i = l_j \cap \alpha > A \\ 100 & l_i \neq l_j \cap \alpha \leq A \\ \infty & l_i \neq l_j \cap \alpha > A \end{cases}$$

2.4 Texture Block Color Adjustment

The optimal view selection method proposed reduces the probability of selecting different image labels for topologically adjacent triangular faces, thereby reducing the number of texture blocks that require boundary color adjustment.

Global adjustment and **local Poisson image editing methods** are used for color correction.



1. Research background
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Experimental data & Environment

- **Datasets**:

(1) Dortmund (584 images, 8176×6132, Strecha et al. 2008)

(2) Urban(4200 images) & Country-Garden(1359 images)

- **Key Features**

(1) Buildings, roads, trees, moving vehicles

(2) Dynamic scenes + complex lighting

- **Hardware**

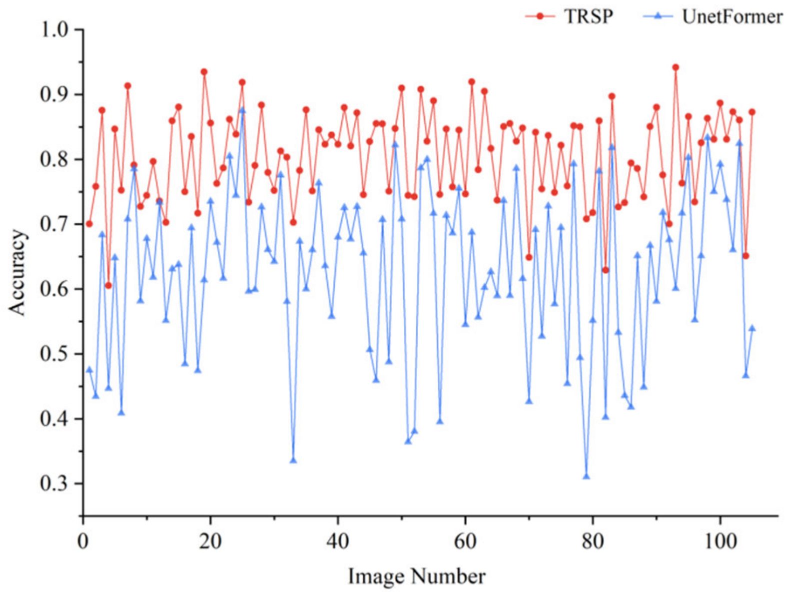
Windows 10, Intel i9, 128GB RAM

Experiments

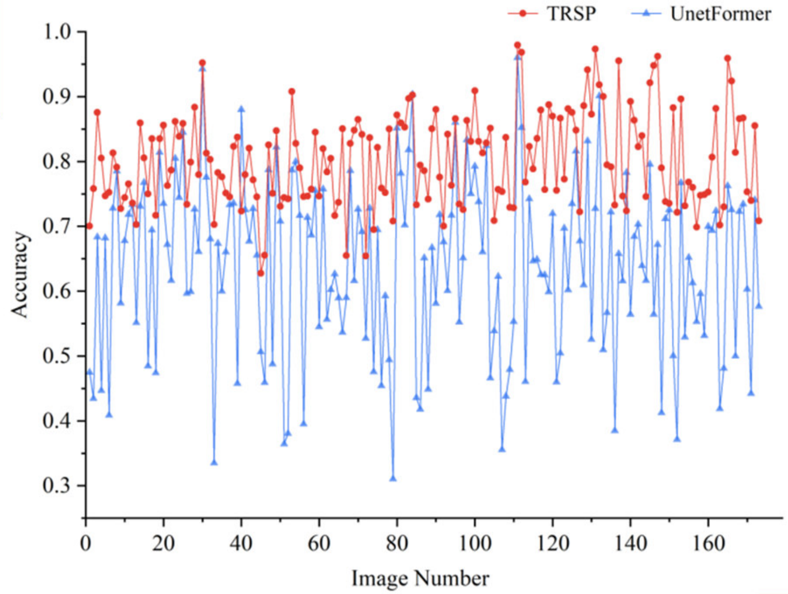
1. Evaluation of the semantic performance of the 3D surface model
2. Quantitative evaluation of texture clarity
3. Qualitative evaluation of texture clarity
4. Comparison and analysis of the removal of moving objects

3.1 Evaluation of the semantic performance of the 3D surface model

3.1.1 Semantic Accuracy Evaluation of 3D Model



(a) DortmundSub

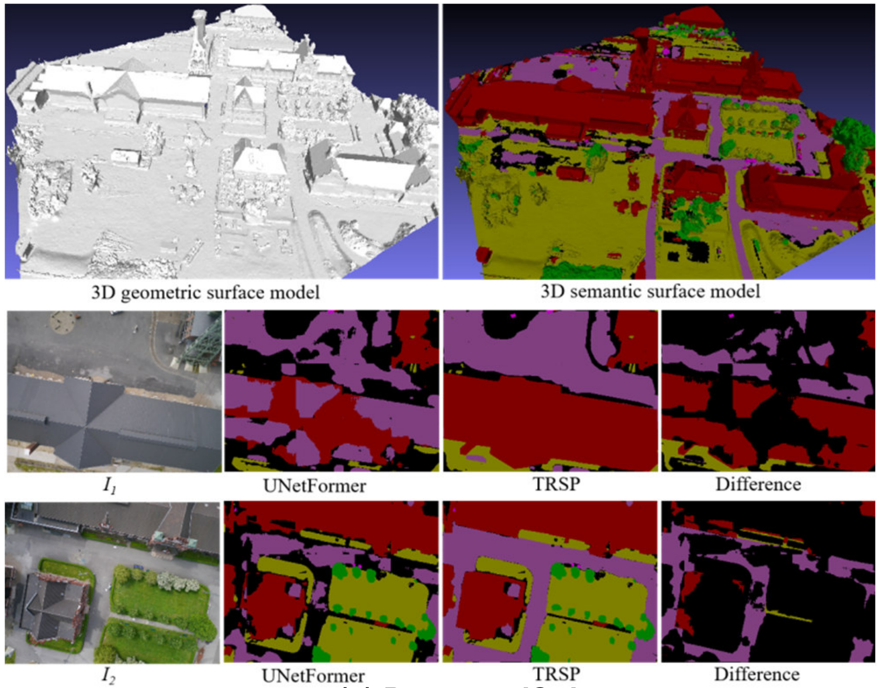


(b) UrbanSub

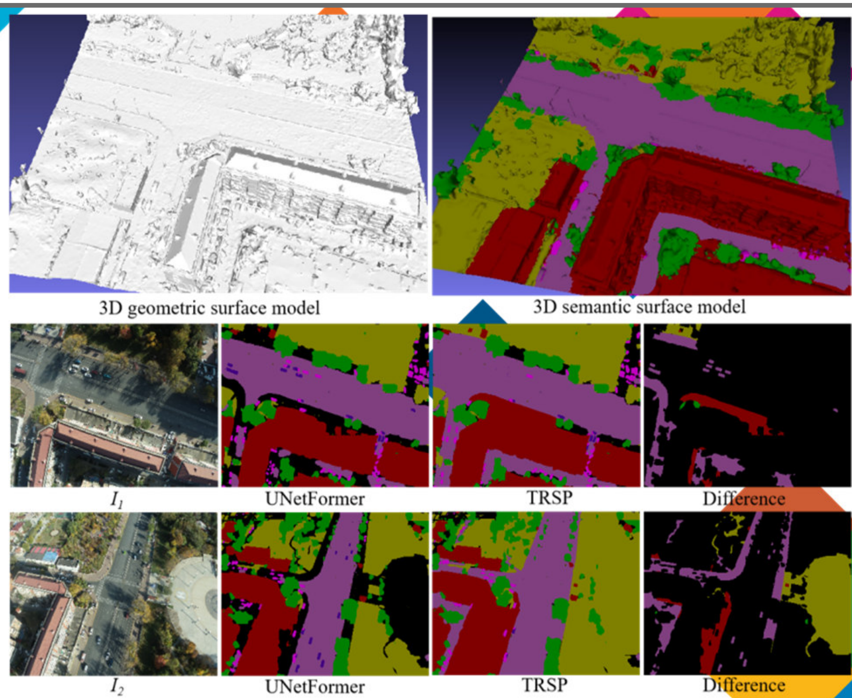
Compared with the 2D semantic segmentation results of UNetFormer, the proposed method has greater semantic accuracy in both sets of scenarios.

3.1.2 Evaluation of semantic information extraction

- Fixed mislabeled pixels (e.g., roads→buildings)
- Removed moving objects via neighbor propagation



(a) DortmundSub



(b) UrbanSub

3.2 Texture Clarity (Quantitative)

3.2.1 View Selection Impact on Texture Clarity

Core Metrics:

- **Gradient Magnitude** ($Grad_{ij}$): Reflects image sharpness.
- **Angle Cosine** (W_{angle}): Measures alignment between view direction and surface normal.
- **Distance Factor** (W_{dis}): Evaluates proximity to image principal point.

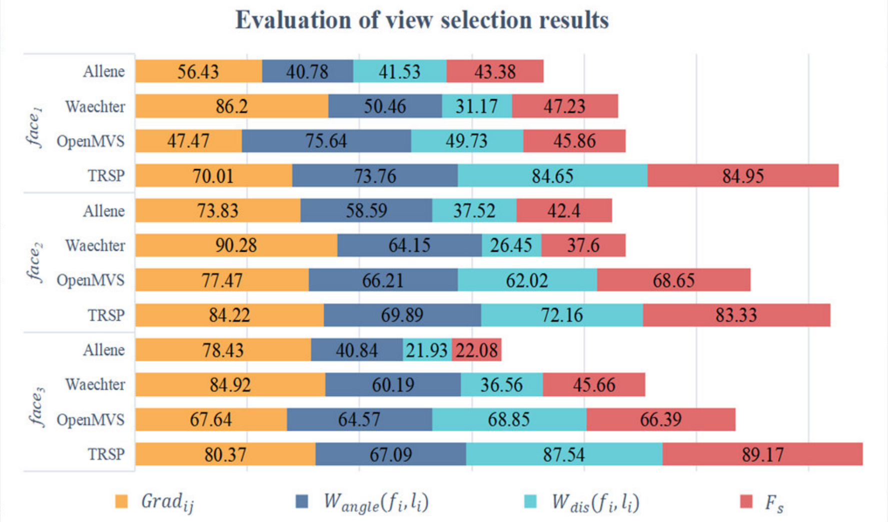
Comprehensive Score (F_s):

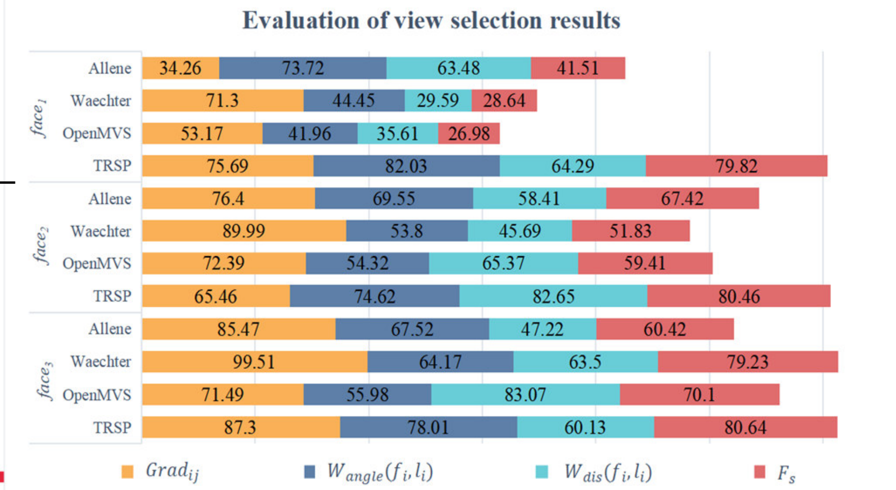
$$F_s = \frac{3 * (Grad_{ij} * W_{angle}(f_i, l_i) * W_{dis}(f_i, l_i))}{(Grad_{ij} + W_{angle}(f_i, l_i) + W_{dis}(f_i, l_i)) * \boldsymbol{Max}(F_s)}$$

3.2.1 View Selection Impact on Texture Clarity

Tab1. View selection metrics for Scene1 & Scene2

Dataset	Method	*face*$_1$	*face*$_2$	*face*$_3$
Scene1	Allene	56.43/40.78/41.53/43.38	73.83/58.59/37.52/42.40	78.43/40.84/21.93/22.08
	Waechter	**86.20**/50.46/31.17/47.23	**90.28**/64.15/26.45/37.60	**84.92**/60.19/36.56/45.66
	OpenMVS	47.47/**75.64**/49.73/45.86	77.47/66.21/62.02/68.65	67.64/64.57/68.85/66.39
	TRSP	70.01/73.76/**84.65**/**84.95**	84.22/**69.89**/**72.16**/**83.33**	80.37/**67.09**/**87.54**/**89.17**
Scene2	Allene	34.26/73.72/63.48/41.51	76.40/69.55/58.41/67.42	85.47/67.52/47.22/60.42
	Waechter	71.30/44.45/29.59/28.64	**89.99**/53.80/45.69/51.83	**99.51**/64.17/63.50/79.23
	OpenMVS	53.17/41.96/35.61/26.98	72.39/54.32/65.37/59.41	71.49/55.98/**83.07**/70.10
	TRSP	**75.69**/**82.03**/**64.29**/**79.82**	65.46/**74.62**/**82.65**/**80.46**	87.30/**78.01**/60.13/**80.64**





Result :

- TRSP: Best balance of gradient, angle, distance
- Outperformed Waechter/Allene in 84% of cases

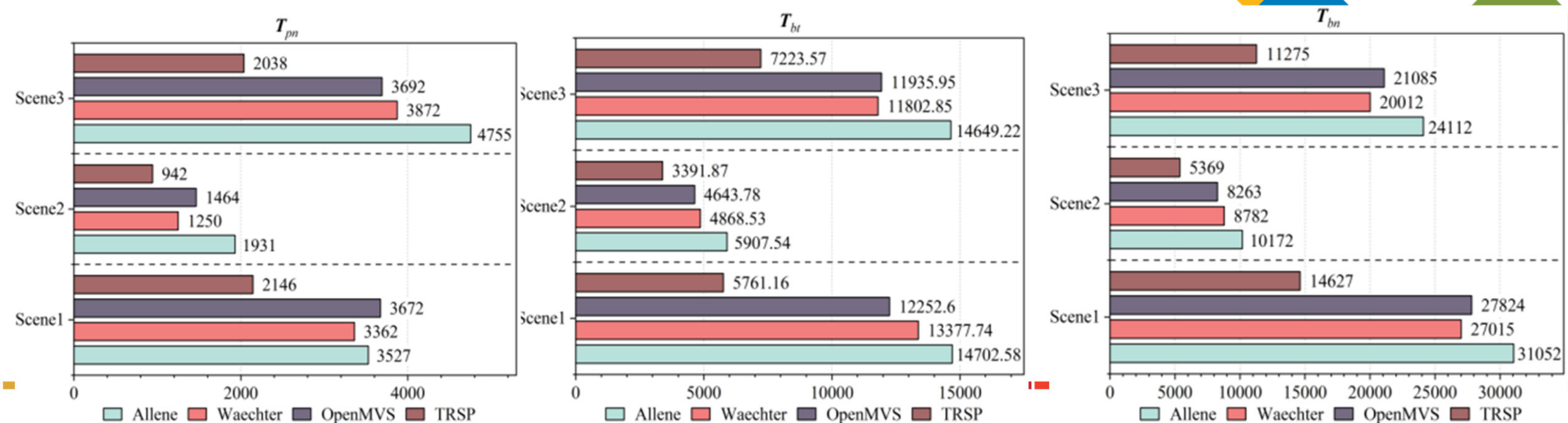
3.2.2 The Effect of Color Adjustment on Texture Clarity

Measurement (Li et al., 2020; F. Wang et al., 2022):

- the number of texture blocks
- the number of color adjustment borders
- the total length of color adjustment borders

Result:

- 57% fewer texture blocks vs. Allene 50% shorter
- color seams → Sharper details



The texture block distributions in the 3D scene corresponding to the four methods

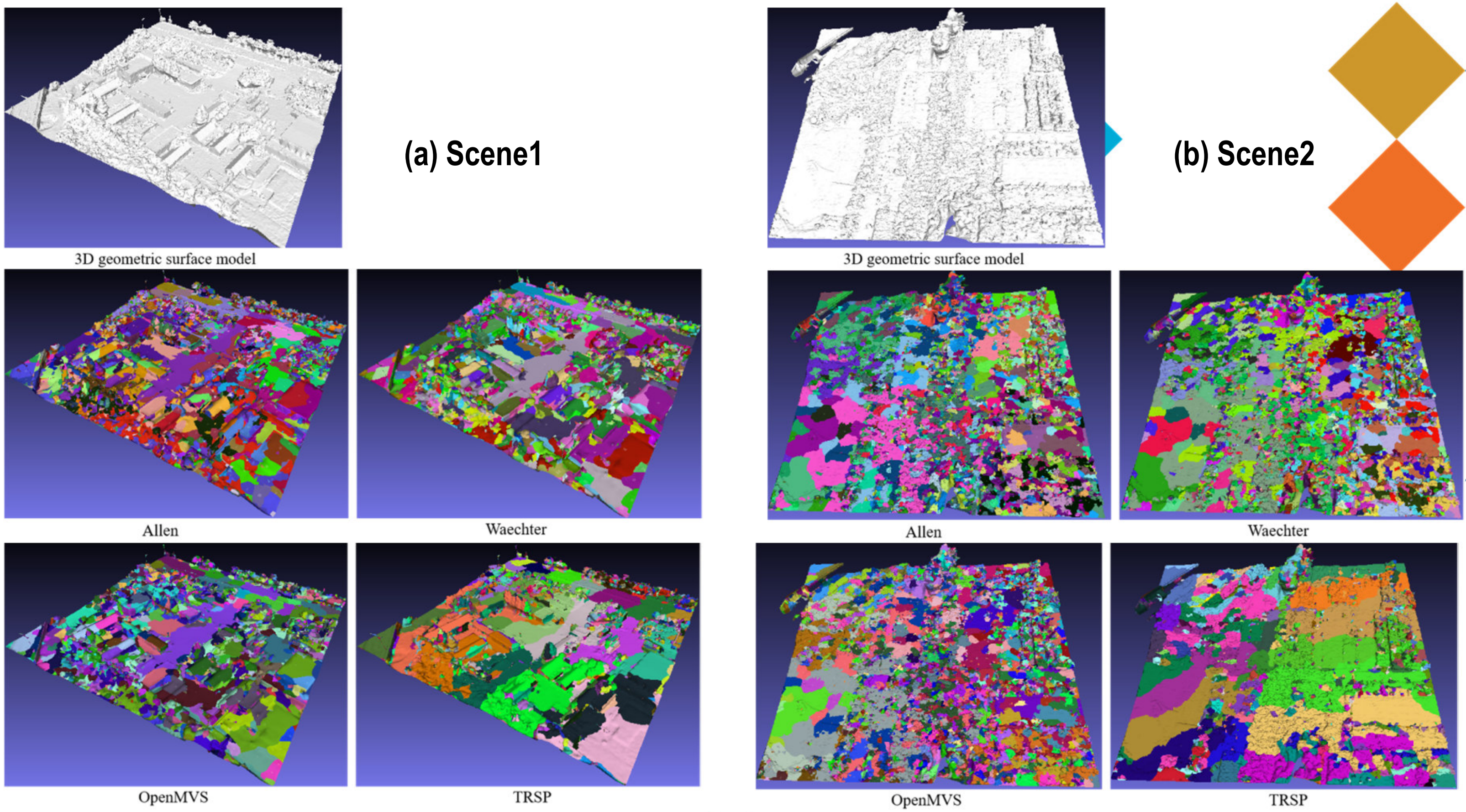
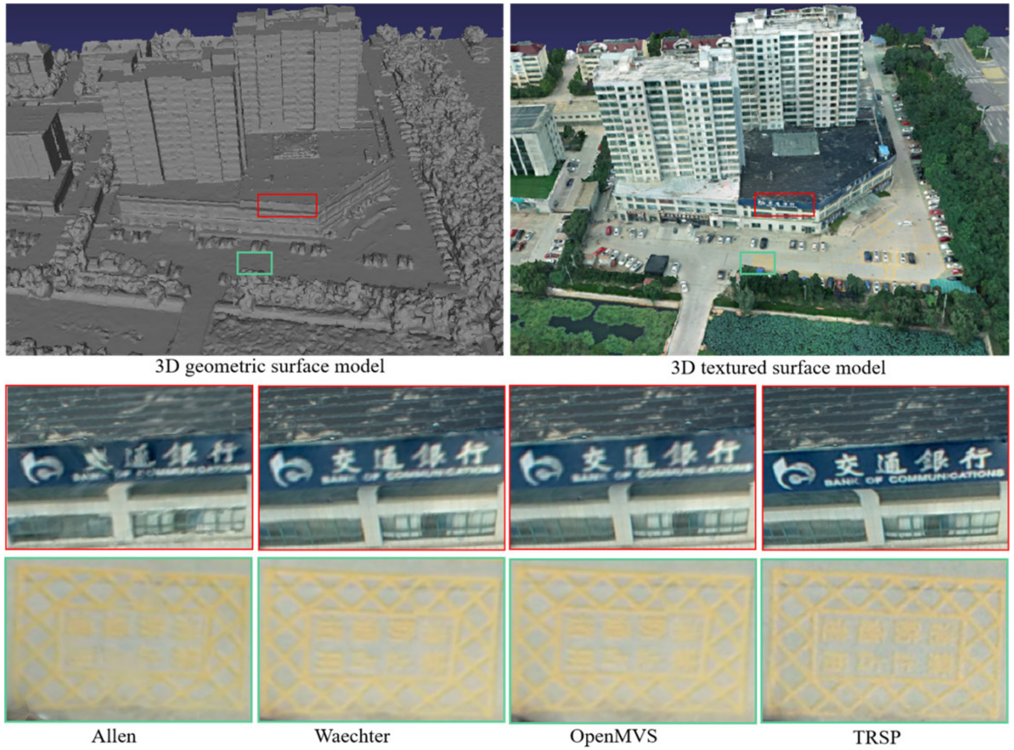


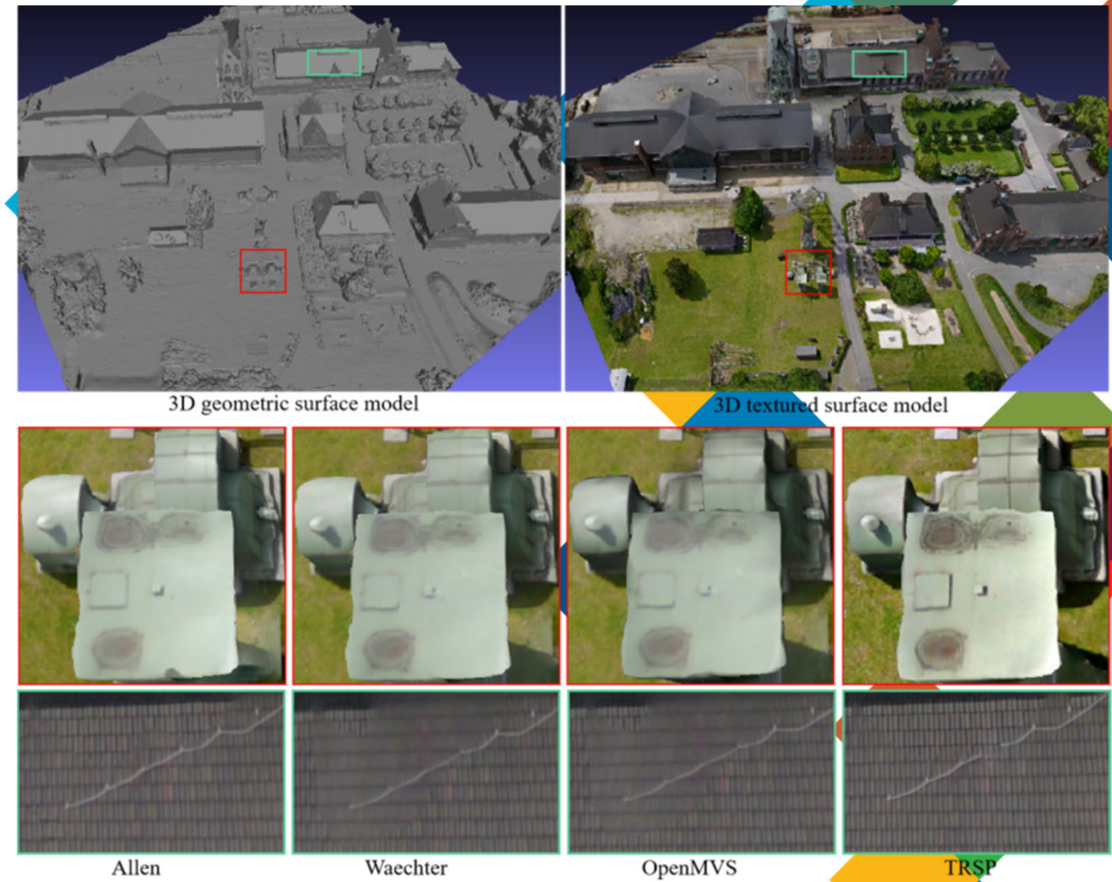
*Fig (a),(b) show the texture block distributions in the 3D scene corresponding to the four methods. The proposed method has **the smallest number of texture blocks**, and **each is larger**.*

3.3 Texture Clarity (Qualitative)

3.3.1 The texture clarity of the 3D surface model



(a) Building Region(Oblique Photography)

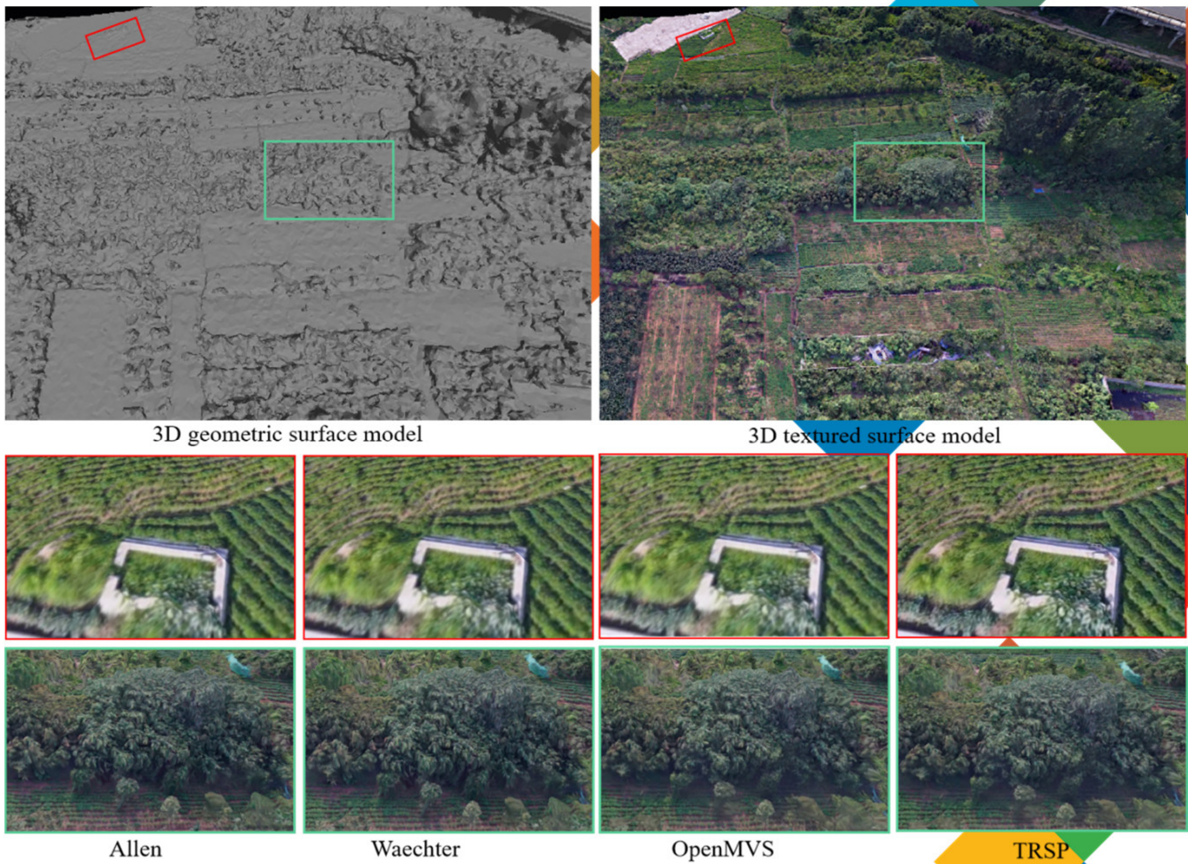


(b) Building Region(ISPRS)

3.3.2 Redundancy Reduction in Complex Geometries

Vegetation-Specific Optimization:

- **Smoothing Term Adaptation**: Penalizes view switches for fragmented surfaces.
- **Result**: **50% fewer texture blocks** compared to baselines



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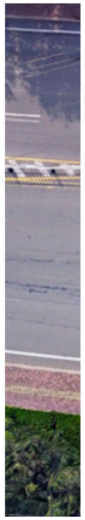

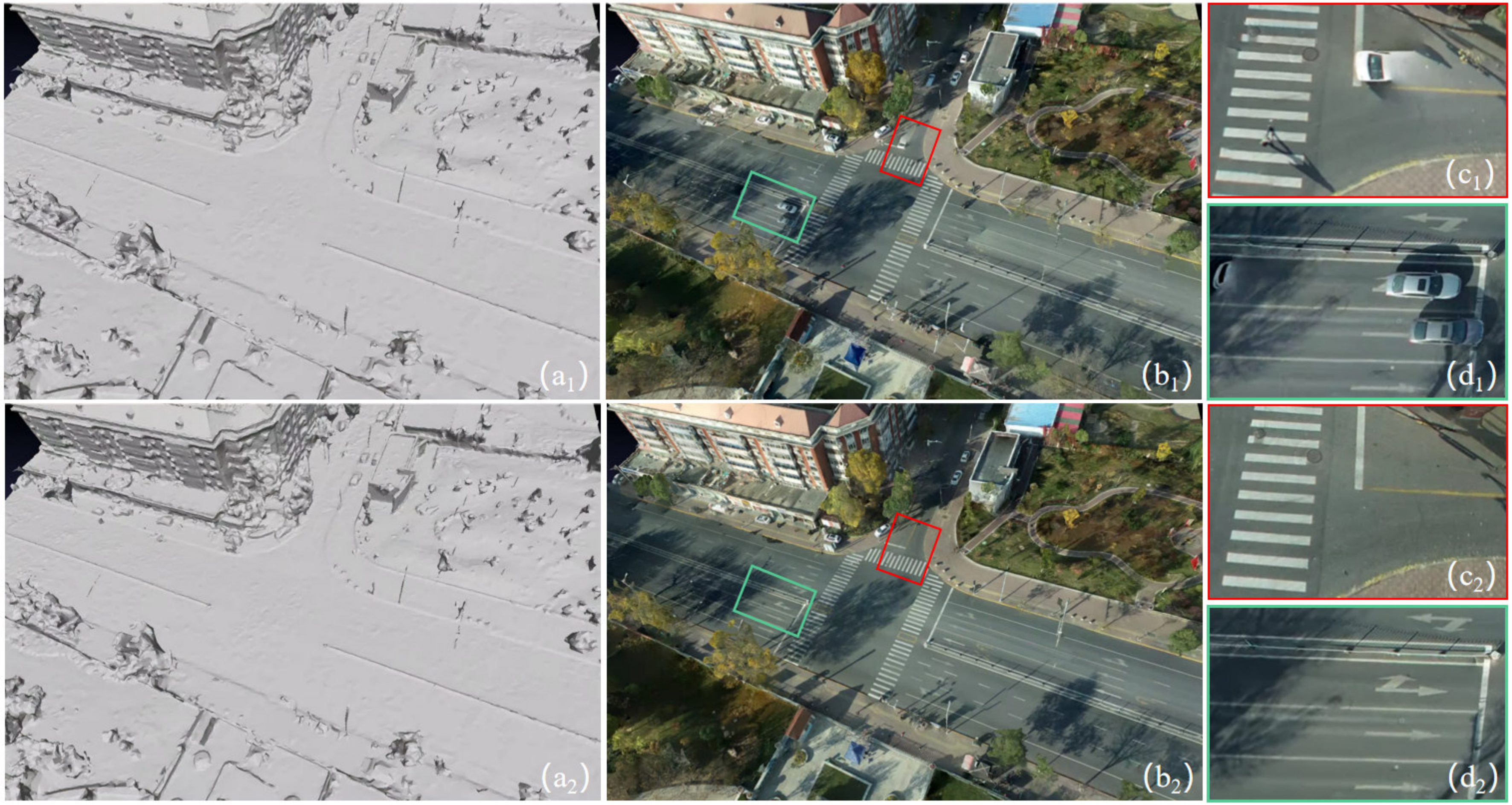

Waechter

TRSP

- Res

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The most relevant SDGs related to the presentation and theme of this session

1st relevant SDG: 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

2nd relevant SDG: 11 SUSTAINABLE CITIES AND COMMUNITIES

3rd relevant SDG: 13 CLIMATE ACTION

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THANKS