DC-Gaussian: Improving 3D Gaussian Splatting for Reflective Dash Cam Videos

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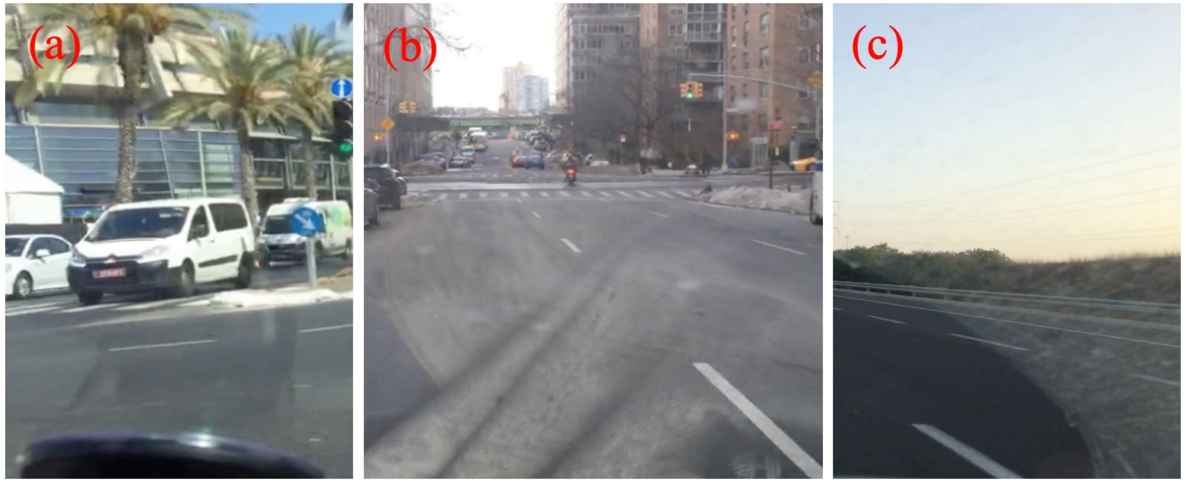
3DGS on dash cam videos is untapped.

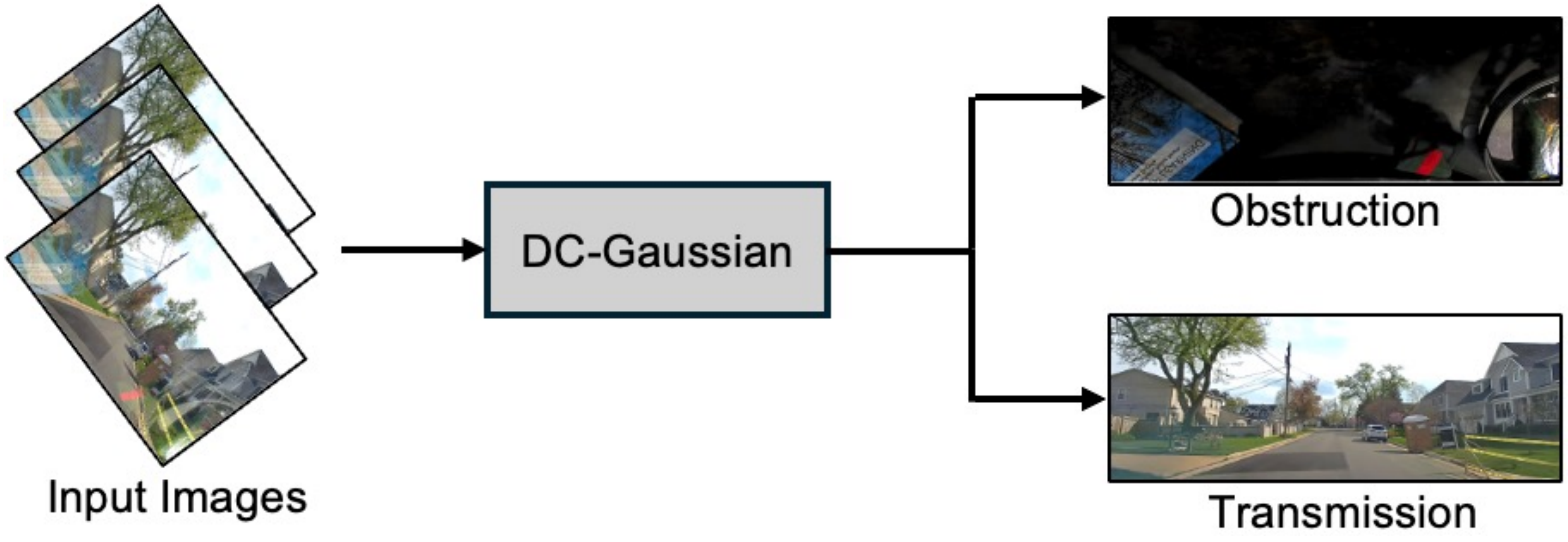
- The advance of neural rendering techniques openes up new possibilities in autonomous driving.
- Existing methods are primarily designed for videos collected by autonomous cars.
- Dash cam videos deeply reflect the diversity and complexity of real-world traffic scenarios.

Applying 3DGS on dash cam videos is challenging.

- Existing obstruction removal methods fall short on the complex obstructions on windshield.
- Naively training 3DGS on dash cam videos faces strong ambiguity between obstructions and driving scenes.
- Varying illumination in real world makes this task even more challenging.



Our Task: Novel View Synthesis and Obstruction Removal



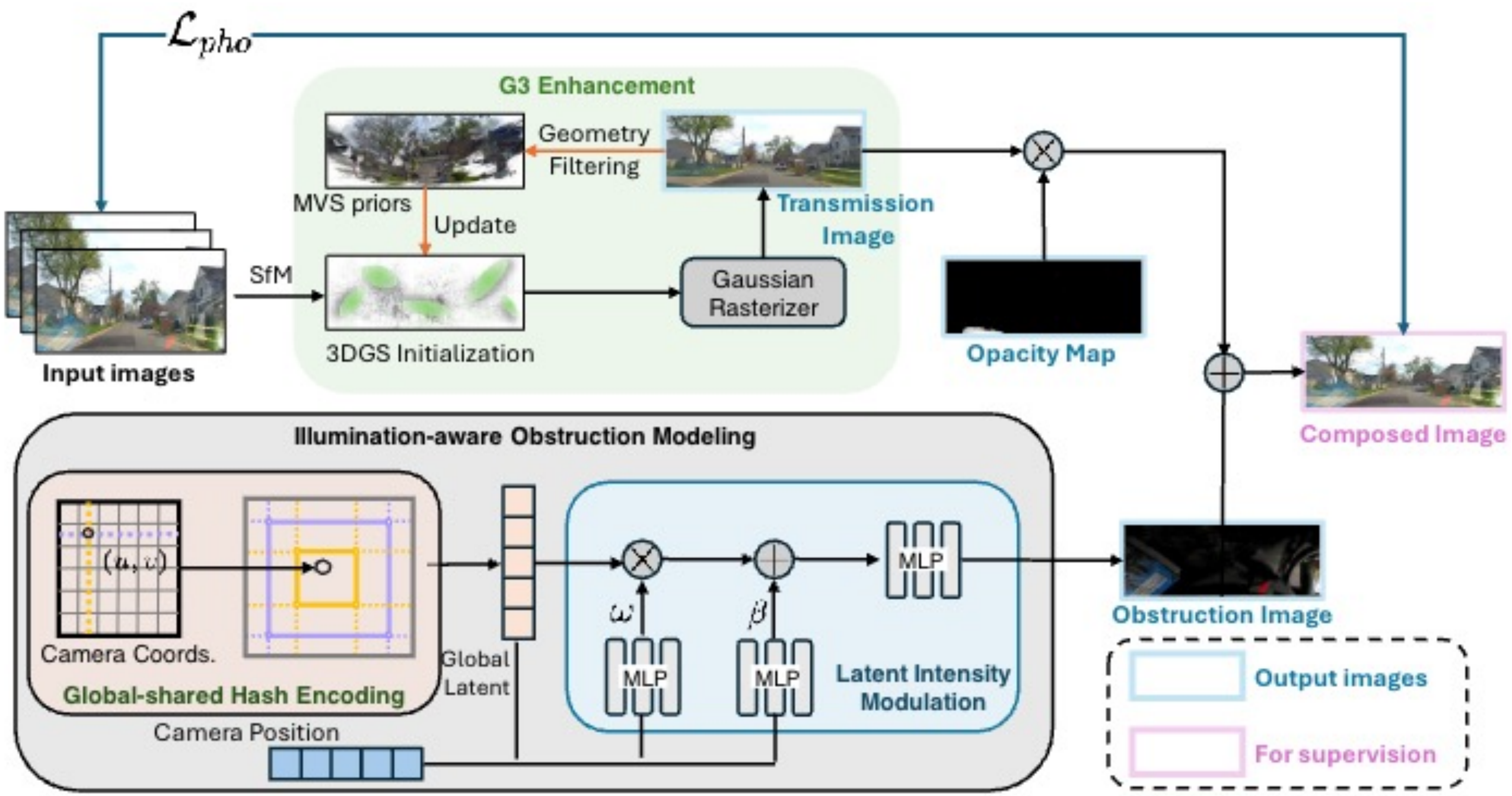
- **Novel view synthesis**: synthesizing images at novel view perspectives.
- **Obstruction removal**: removing obstructions by decomposing the images.

Observations

- **Observation 1** Reflections are from objects inside the car. Reflections and occlusions are both relatively stationary with the car.
- **Observation 2** The strength of reflections are conditioned on the incident light, which is changing as cars move along the road.

Pipeline

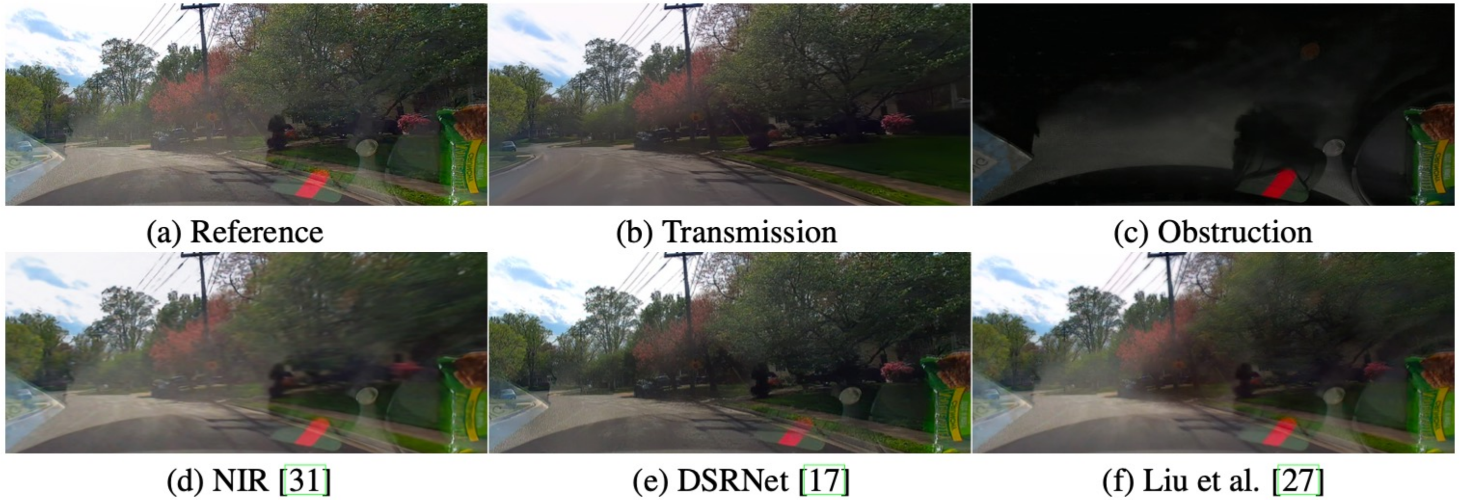
- Global-shared Hash Encoding utilizes the static motion prior of obstructions.
- Latent Intensity Modulation grasps the intensity changes of reflections.
- MVS priors is leveraged to enhance the geometry of 3D Gaussians.



Qualitative Results

- Our method surpasses 3DGS in both rendering quality and geometry.

- Our method achieves significantly better results in obstruction removal.



Quantitative Results

Table 1: Evaluation of novel view synthesis on BDD100K and DCVR. We indicate the best and second best with bold and underlined respectively. Our method consistently outperforms state-of-the-art methods in both datasets and all the evaluation metrics.

Method	BDD100K			DCVR		
	PSNR ↑	SSIM ↑	LPIPS ↓	PSNR ↑	SSIM ↑	LPIPS ↓
ZipNeRF [4]	27.89	0.875	0.176	<u>24.41</u>	<u>0.786</u>	<u>0.228</u>
GaussianPro [9]	27.75	0.894	0.192	23.71	0.770	0.270
3DGS [19]	<u>28.02</u>	<u>0.897</u>	<u>0.188</u>	23.73	0.783	0.248
DCGaussian (Ours)	**29.44**	**0.914**	**0.143**	**24.74**	**0.822**	**0.202**

Table 2: Ablations studies on DCVR. Metrics are calculated on obstruction influenced areas.

NOM	AD	LIM	G3E	PSNR ↑	SSIM ↑	LPIPS ↓
✗	✗	✗	✗	23.99	0.738	0.287
✓	✗	✗	✗	25.21	0.776	0.252
✓	✓	✗	✗	25.65	0.791	0.236
✓	✓	✓	✗	25.90	0.798	0.229
✓	✓	✓	✓	**26.30**	**0.814**	**0.210**