

# BEVCA

## Towards Effective and Transferable Physical Camouflage against Multi-View BEV-based 3D Perception in Autonomous Driving

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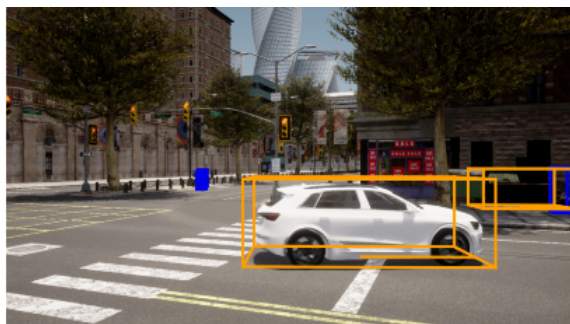
NeurIPS 2026



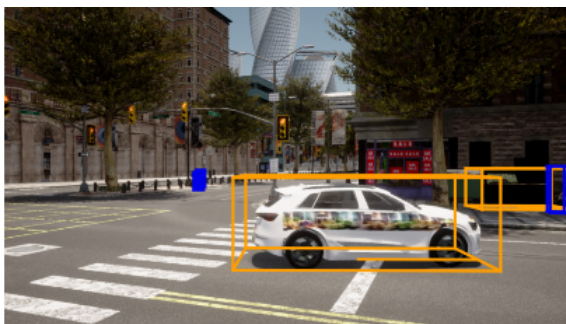
The optimized texture on a full-size vehicle

# Camouflage across camera views

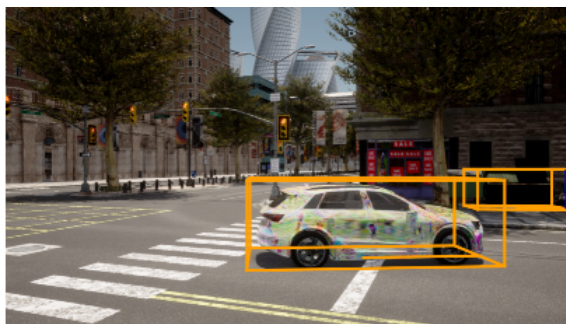
A shared vehicle texture must affect a perception model that fuses six camera views.



(a) Normal



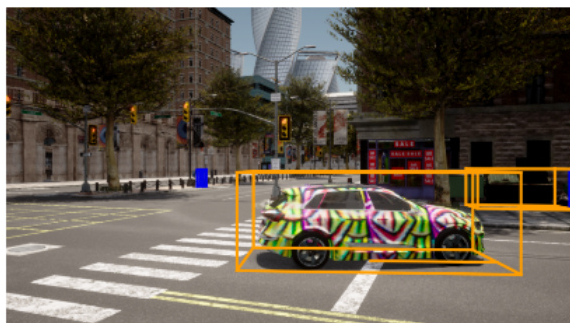
(b) AdvPatch



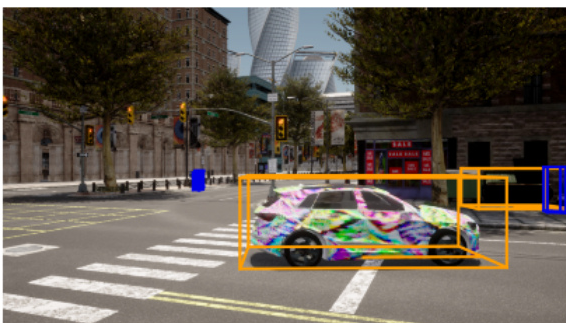
(c) FCA



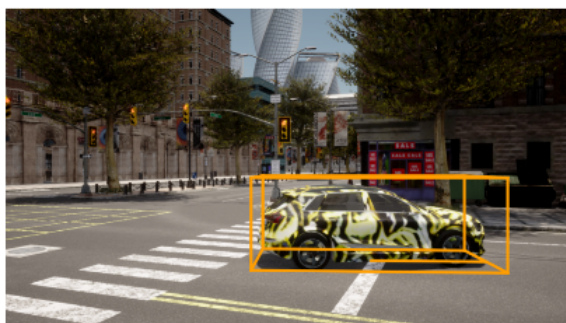
(d) DTA



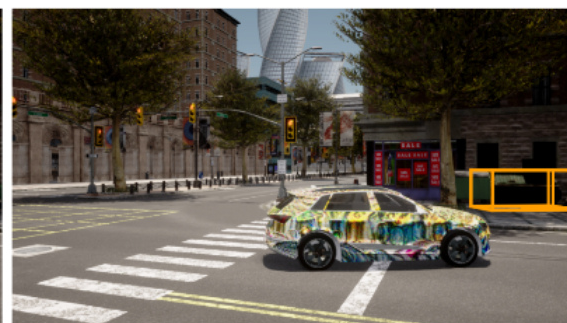
(e) ACTIVE



(f) RAUCA



(g) CNCA

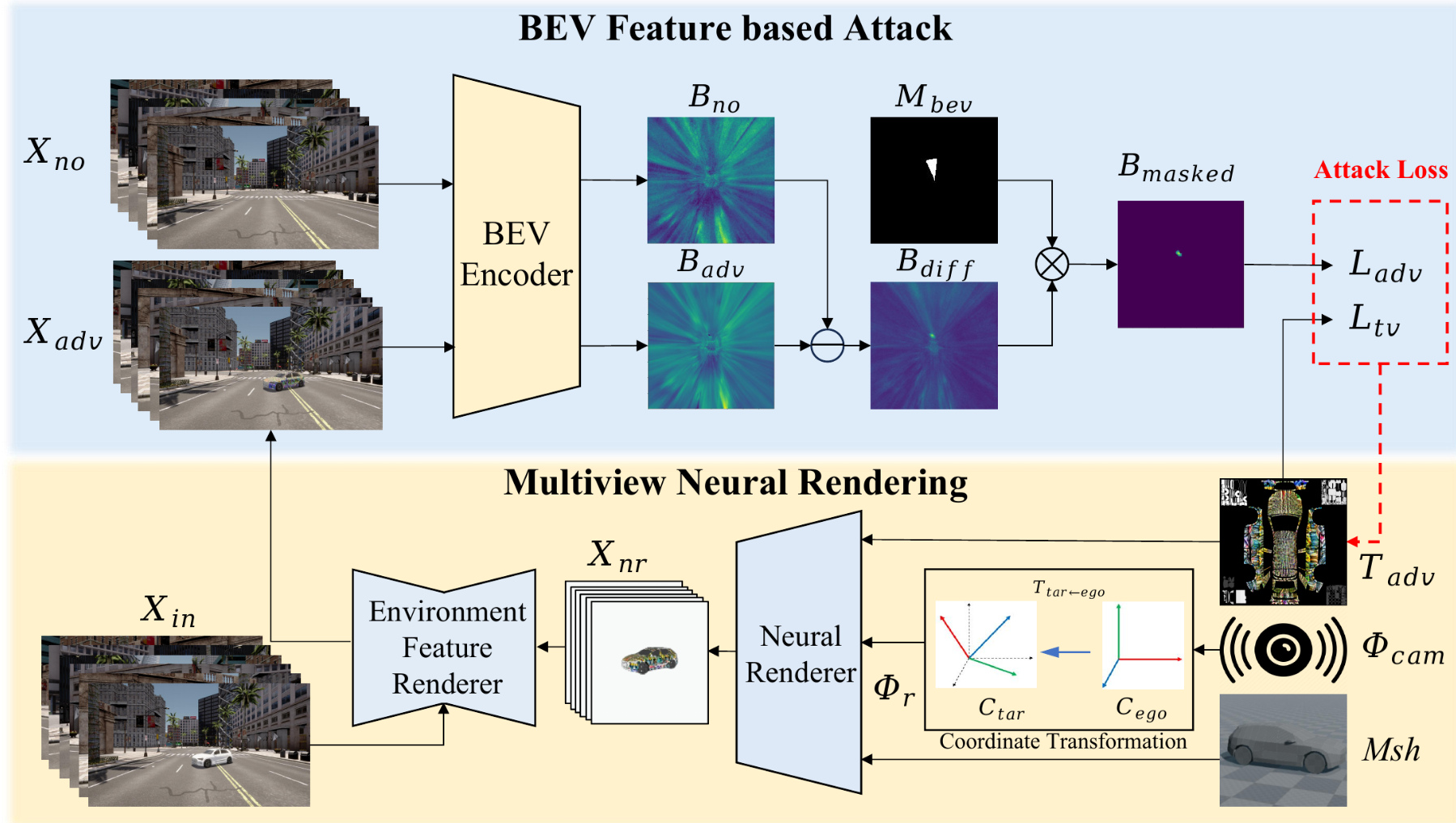


(h) BEVCA

The example shows BEVCA evading 3D detection while the evaluated baseline textures retain detections.

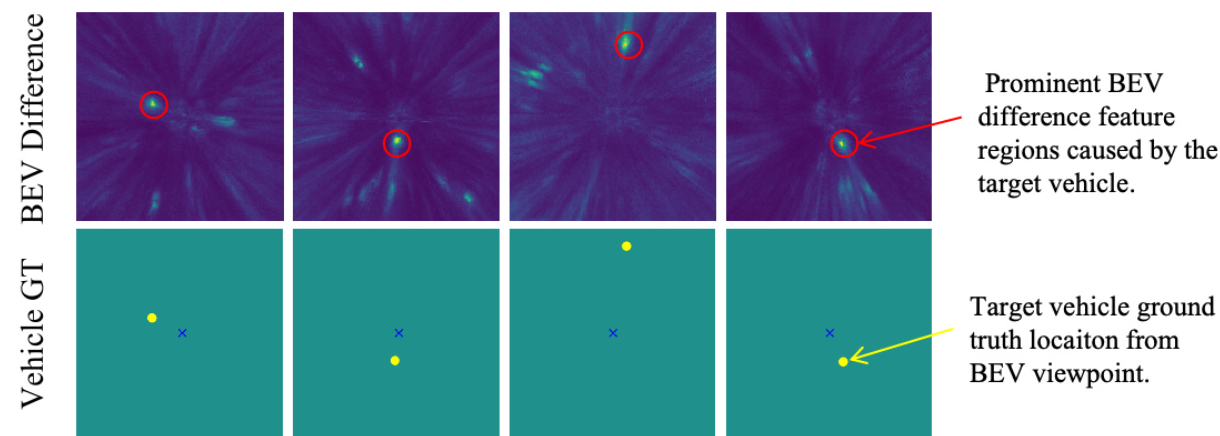
# BEVCA framework

Multi-view rendering connects a shared physical texture to a local BEV feature objective.



# A local BEV objective

The objective suppresses the vehicle’s BEV feature difference within a position-based mask.



BEV difference and vehicle position

$$\mathbf{B}_{diff} = |\mathbf{B}_{adv} - \mathbf{B}_{no}|$$
$$\mathbf{B}_{masked} = \mathbf{B}_{diff} \times \mathbf{M}_{bev}$$

Texture loss = masked difference + TV regularization

## Loss ablation on BEVFormer-Base

| Objective         | Car AP       |
|-------------------|--------------|
| Detection output  | 0.564        |
| Encoder features  | 0.392        |
| Whole BEV         | 0.612        |
| <b>Masked BEV</b> | <b>0.191</b> |

Lower AP indicates a stronger attack  
Source: Table 3

# Transfer across models and tasks

One texture optimized on BEVFormer-Base transfers to the other evaluated perception models.

## 3D detection: Car AP

| Texture      | Base<br>(source) | Small        | Tiny         | Base<br>Seg-Det | Small<br>Seg-Det |
|--------------|------------------|--------------|--------------|-----------------|------------------|
| Normal       | 0.618            | 0.721        | 0.514        | 0.750           | 0.634            |
| CNCA         | 0.567            | 0.626        | 0.404        | 0.634           | 0.523            |
| <b>BEVCA</b> | <b>0.191</b>     | <b>0.285</b> | <b>0.381</b> | <b>0.329</b>    | <b>0.331</b>     |

## BEV segmentation: vehicle IoU

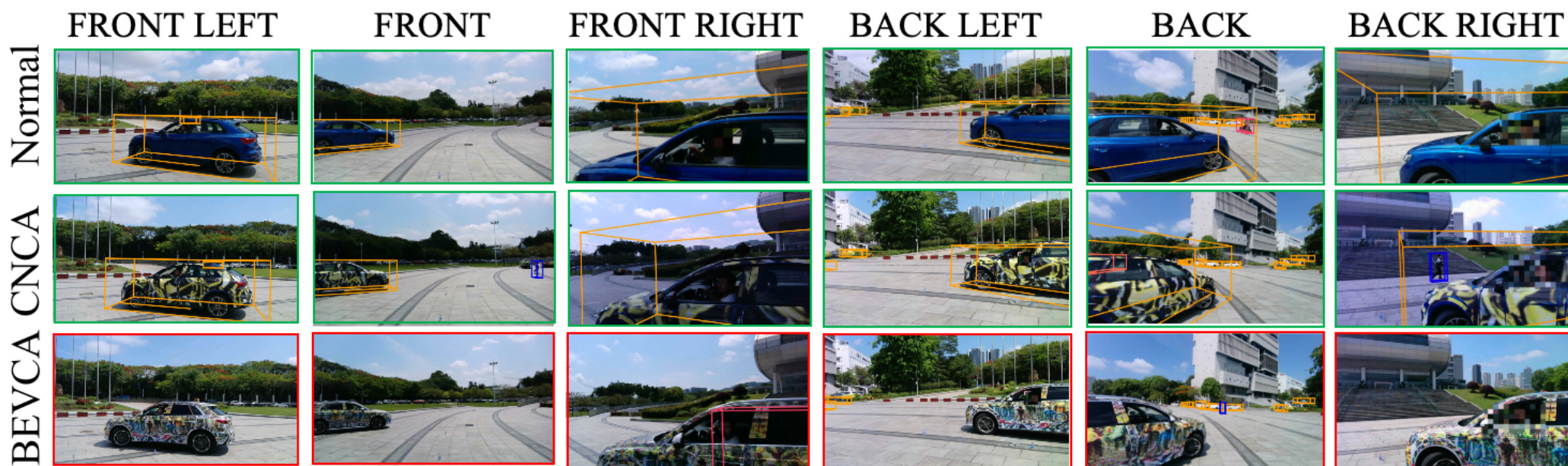
| Texture      | LSS          | CVT          | SinBEVT      |
|--------------|--------------|--------------|--------------|
| Normal       | 0.509        | 0.609        | 0.570        |
| CNCA         | 0.306        | 0.401        | 0.360        |
| <b>BEVCA</b> | <b>0.253</b> | <b>0.307</b> | <b>0.273</b> |

**Lowest AP and IoU across all eight models among the textures evaluated in Table 1.**

# Physical evaluation

**51.18% mean black-box ASR**

Full-size Audi, six cameras  
150 samples per appearance



| Texture      | BEVFormer<br>Base (source) | BEVFormer<br>Small | BEVDet<br>R50 | BEVDet<br>R50-CBGS |
|--------------|----------------------------|--------------------|---------------|--------------------|
| CNCA         | 30.00%                     | 29.49%             | 42.80%        | 34.99%             |
| <b>BEVCA</b> | <b>49.60%</b>              | <b>46.99%</b>      | <b>64.41%</b> | <b>42.13%</b>      |

# Evidence and limitations

CARLA evaluation with original and adapted checkpoints

## BEVFormer-Base

| Checkpoint    | Normal AP | BEVCA AP |
|---------------|-----------|----------|
| Original      | 0.309     | 0.080    |
| CARLA-adapted | 0.618     | 0.191    |

**The attack reduces AP with either checkpoint.**

Both evaluations use CARLA images.  
Sources: Tables 1 and 7

## Scope of the evidence

Offline optimization uses matched no-vehicle scenes and target poses.

Baseline textures are released versions, without re-optimization.

Physical validation uses one vehicle and one capture platform.

# BEVCA

**A local BEV feature objective supports camouflage transfer across perception models and tasks.**

Multi-view rendering carries the same optimized texture into a physical vehicle experiment.

**Project page**



[linyelyuneo.github.io/bevca-project](https://linyelyuneo.github.io/bevca-project)

**Code repository**



[github.com/WAVE-AT-IDEA/BEVCA](https://github.com/WAVE-AT-IDEA/BEVCA)