NeurIPS 2026

# WaveMamba

## Wave-Inspired Cross-Modal Fusion for Robust event-image Semantic Segmentation

Presented by Adeel Feroz Mirza

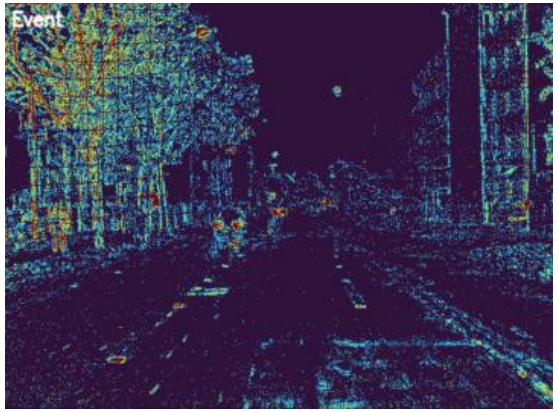
# Complementary sensors, difficult fusion

Images provide appearance. Events capture brightness changes.

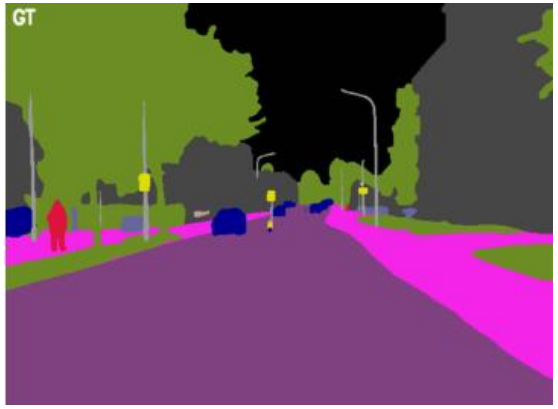
**Image**



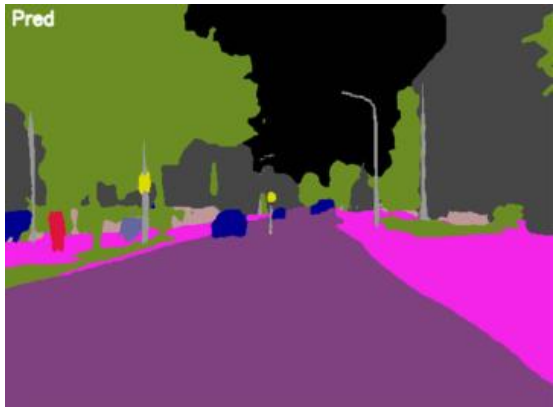

**Events**




**Ground truth**




**WaveMamba**

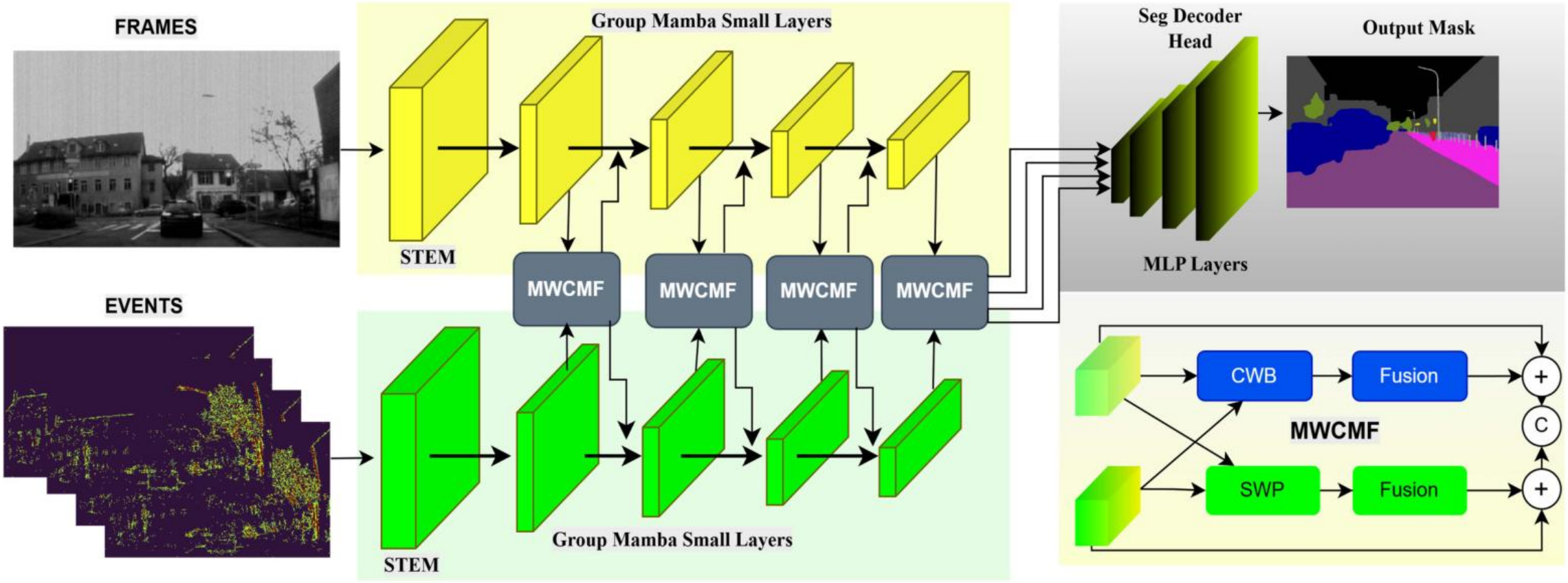



## The challenge

Dense image features and sparse event features describe the same scene differently.

# WaveMamba architecture

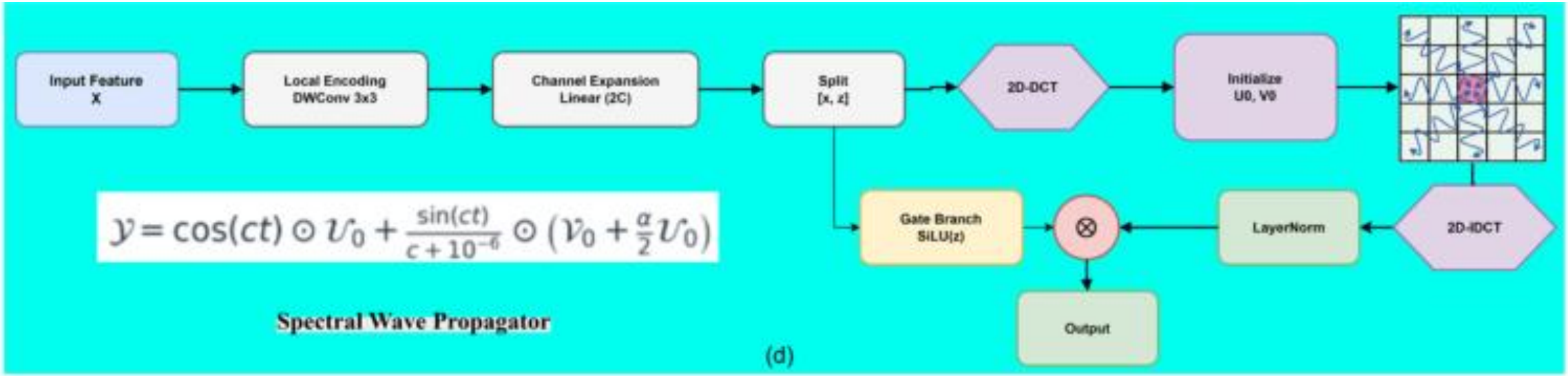
Two GroupMamba encoders with fusion at all four scales




**MWCMF refines both modalities before the next stage and the MLP decoder.**

# Wave-guided gating and Mamba refinement

## Spectral Wave Propagator (SWP)




## Channel-wave path

Cross-modal channel gates
Temporal SSM + channel refinement

## Spatial-wave path

Cross-modal spatial gates
SS2D + spatial refinement

# Higher accuracy on DDD17 and DSEC

## Benchmark mIoU (%)

| Method | DDD17 | DSEC |
|---|---|---|
| EISNet | 75.03 | 73.07 |
| MambaSeg | 77.56 | 75.00 |
| **WaveMamba** | **78.75** | **76.00** |

**+1.19 / +1.00 points**

over MambaSeg on DDD17 / DSEC

## Fusion ablation, fixed GroupMamba

| Fusion | DDD17 | DSEC |
|---|---|---|
| DDIM | 77.80 | 74.70 |
| Wave gates only | 78.33 | 75.70 |
| **Full MWCMF** | **78.75** | **76.00** |

**+0.95 / +1.30 points**

over DDIM with the same backbone

**DDD17: 94.31M parameters, 34.10G MACs, 75 FPS on RTX 3090**

Inference: 200 × 346 pixels, batch 1, FP32

# Robustness to rain and fog

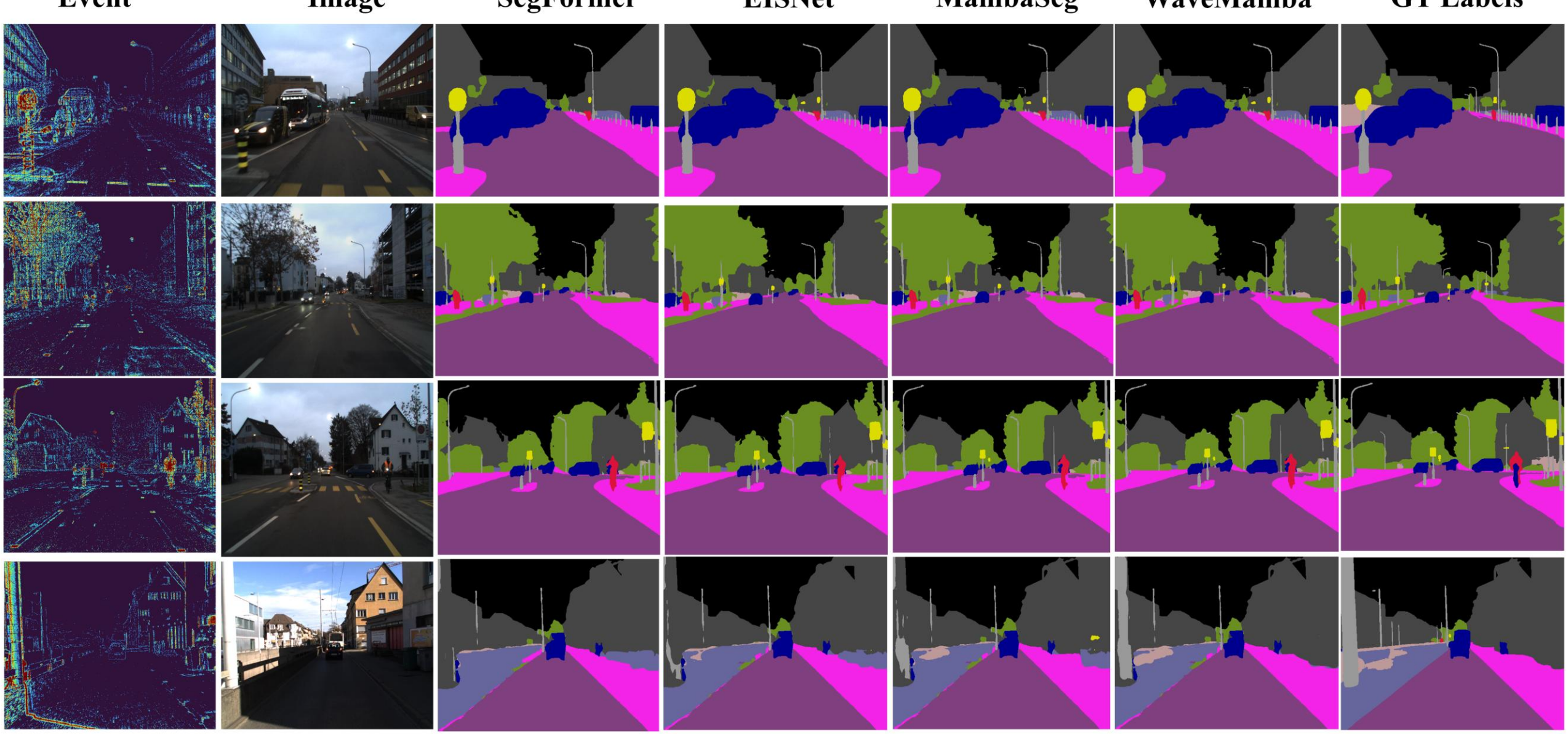
## Matched DSEC protocols, mIoU (%)

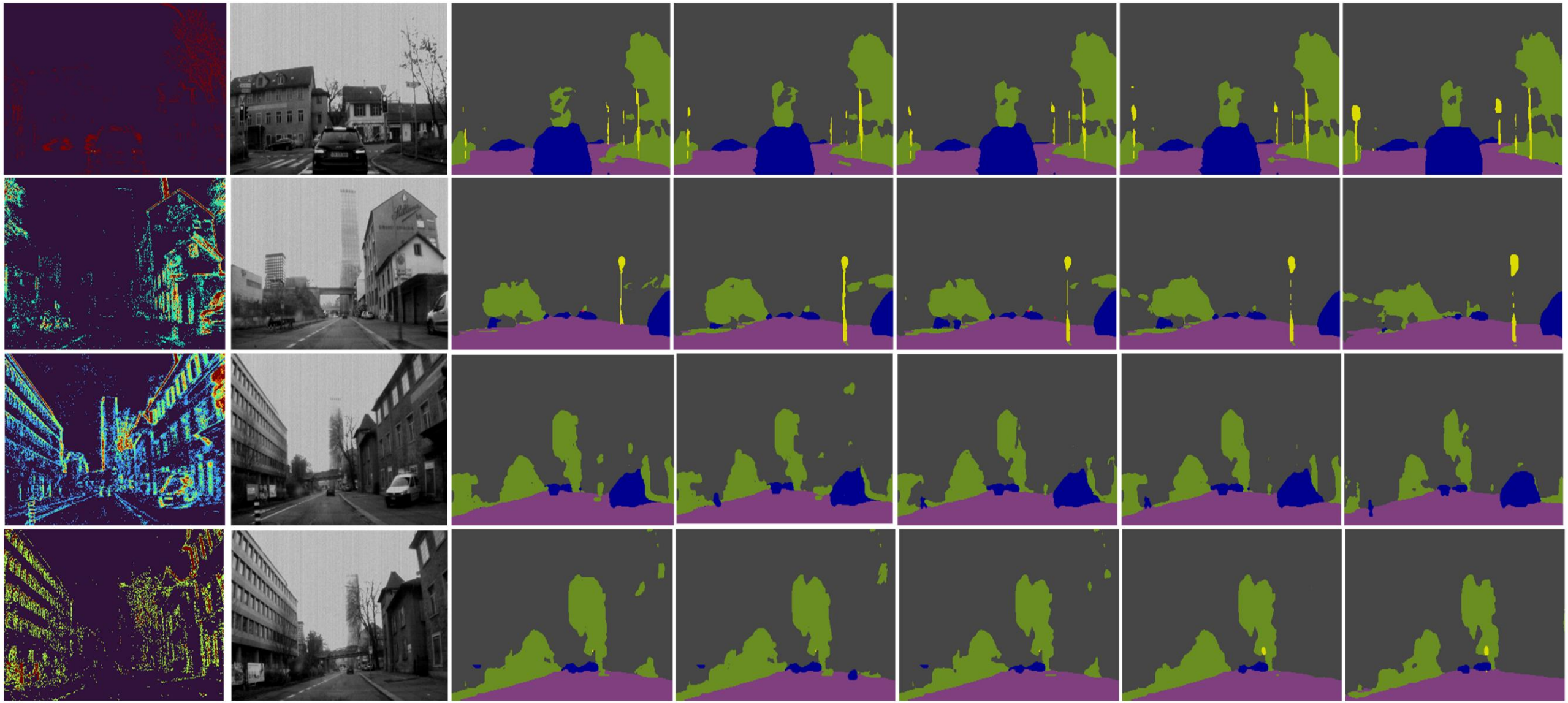
| Method | Clean | Unseen rain/fog | Corruption-aware |
|---|---|---|---|
| EISNet | 73.07 | 61.1 | 71.5 |
| MambaSeg | 75.00 | 63.0 | 72.9 |
| **WaveMamba** | **76.00** | **65.4** | **74.0** |

Unseen: clean training. Corruption-aware: training with rain/fog augmentation.
Synthetic rain/fog affects approximately 50% of validation images.

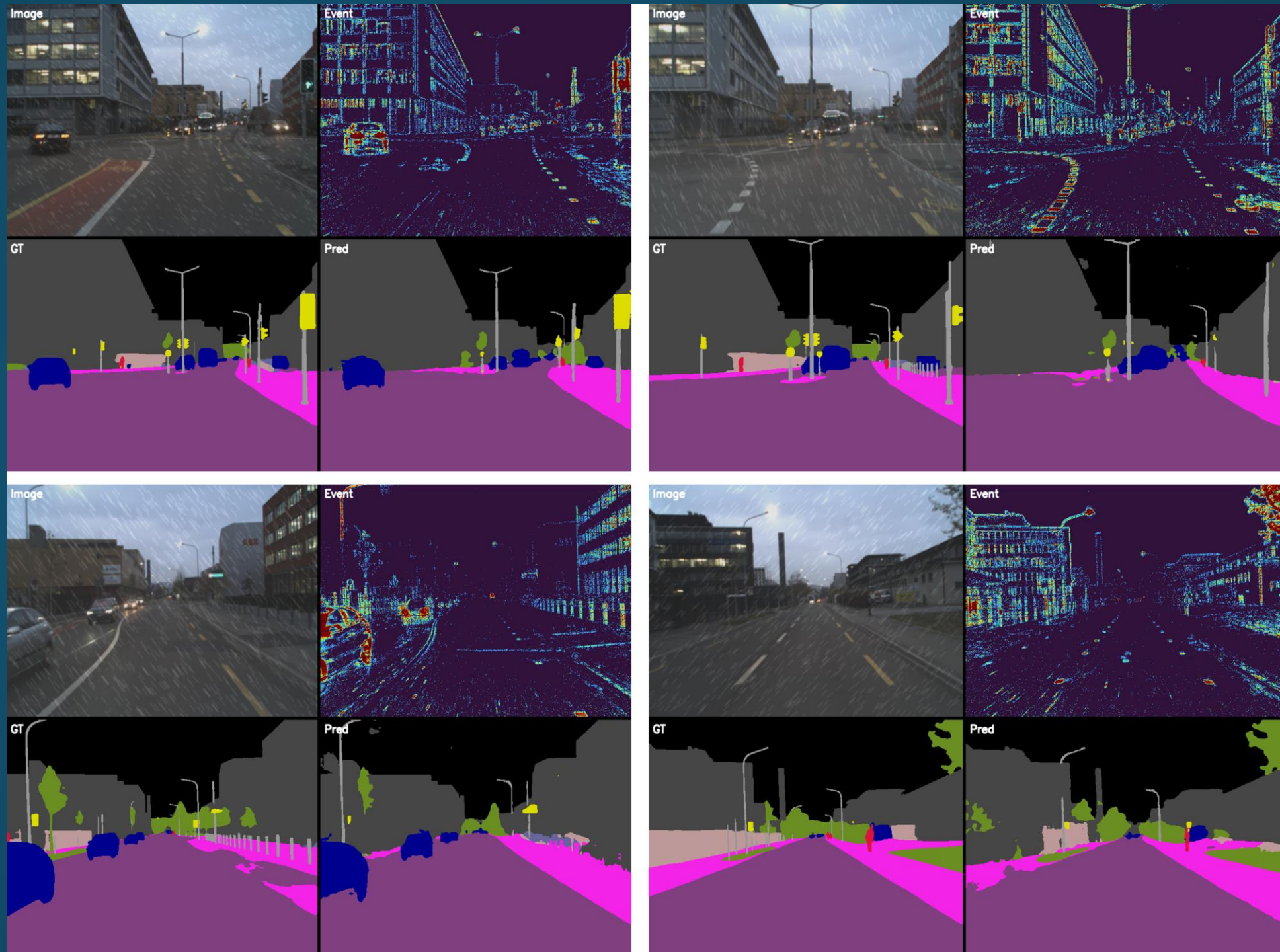
## Wave-guided fusion improves segmentation and resilience to visual degradation.

Code: github.com/adeelferozmirza/WaveMamba


Event
Image
SegFormer
EISNet
MambaSeg
WaveMamba
GT Labels


Event
Image
SegFormer
EISNet
MambaSeg
WaveMamba
GT Labels

# Robustness to rain & fog



NeurIPS 2026

# THANKS