OpenSatMap: A Fine-grained High-resolution Satellite Dataset for Large-scale Map Construction

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Paper：

Dataset：

Project：

❖ Background

Road map construction

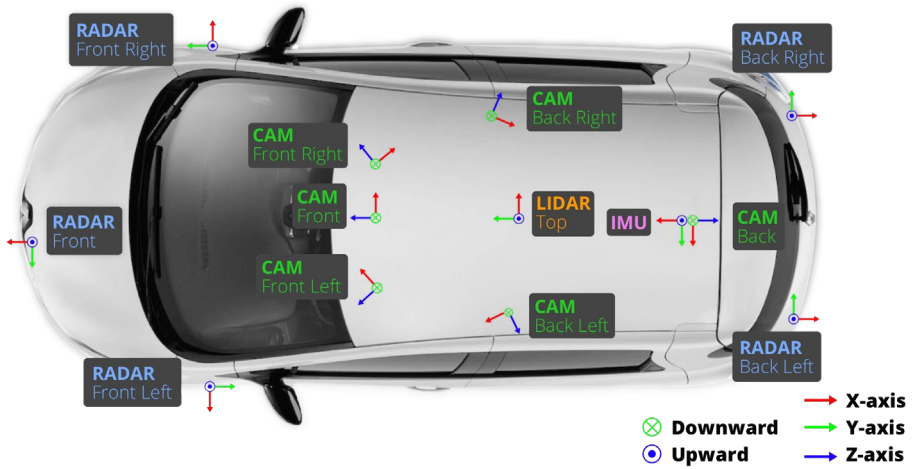
Road map construction is fundamental to many tasks such as navigation and autonomous driving.

❖ Background

❑ Existing Benchmarks

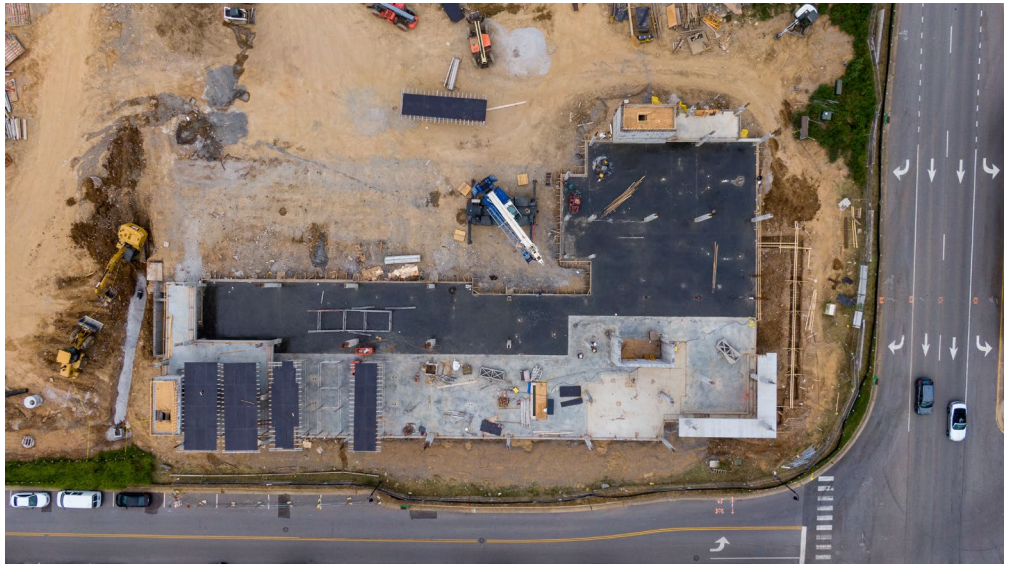
➢ Ego View Map Construction

- Use cameras and radar to construct maps. (HDMapNet, MapTR, …)
- Accurate but expensive.



➢ Satellite Map Construction

- Use satellite images to build maps. (RoadTracer, SPIN, …)
- Cheap but inaccurate.



❖ Background

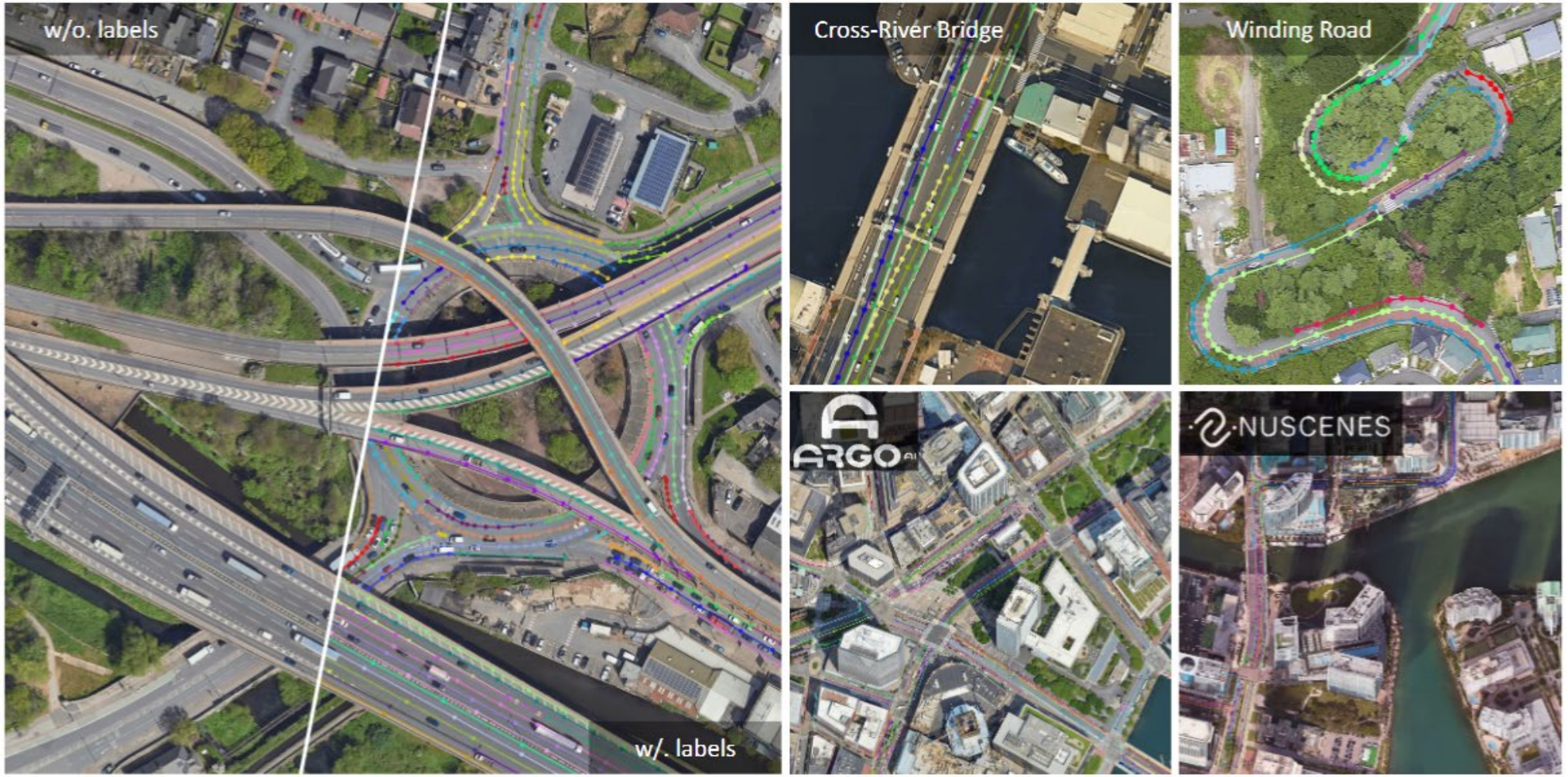
❑ Satellite Map Construction

- Coarse annotations: Semantic-level
- Low resolution: Inadequate for accurate perception of lane lines
- Small Scale: Less than 10k 1024 * 1024 images
- Unalignment with AD benchmarks

Dataset	# of Images*	Resolution	GT Source	Labeling Level	Region
Massachusetts [35]	2513	1.00 *m/pixel*	OSM	Semantic	America
CasNet [13]	77	1.20 *m/pixel*	Manually	Semantic	-
DeepGlobe [16]	8570	0.50 *m/pixel*	QGIS	Semantic	3 Counties
SpaceNet [43]	4481	0.31 *m/pixel*	OSM	Semantic	4 Counties
Roadtracer [6]	4800	0.60 *m/pixel*	OSM	Semantic	6 Counties
Ottawa [33]	235	0.30 *m/pixel*	Manually	Semantic	Canada
CHN6-CUG [48]	4511	0.50 *m/pixel*	Manually	Semantic	China
OpenSatMap (Ours)	7224 31696	0.30 *m/pixel* 0.15 *m/pixel*	Manually	Instance, Vectorized	60 Cities, 19 Countries

❖ OpenSatMap

❑OpenSatMap: A Fine-grained High-resolution Satellite Dataset



❖ OpenSatMap

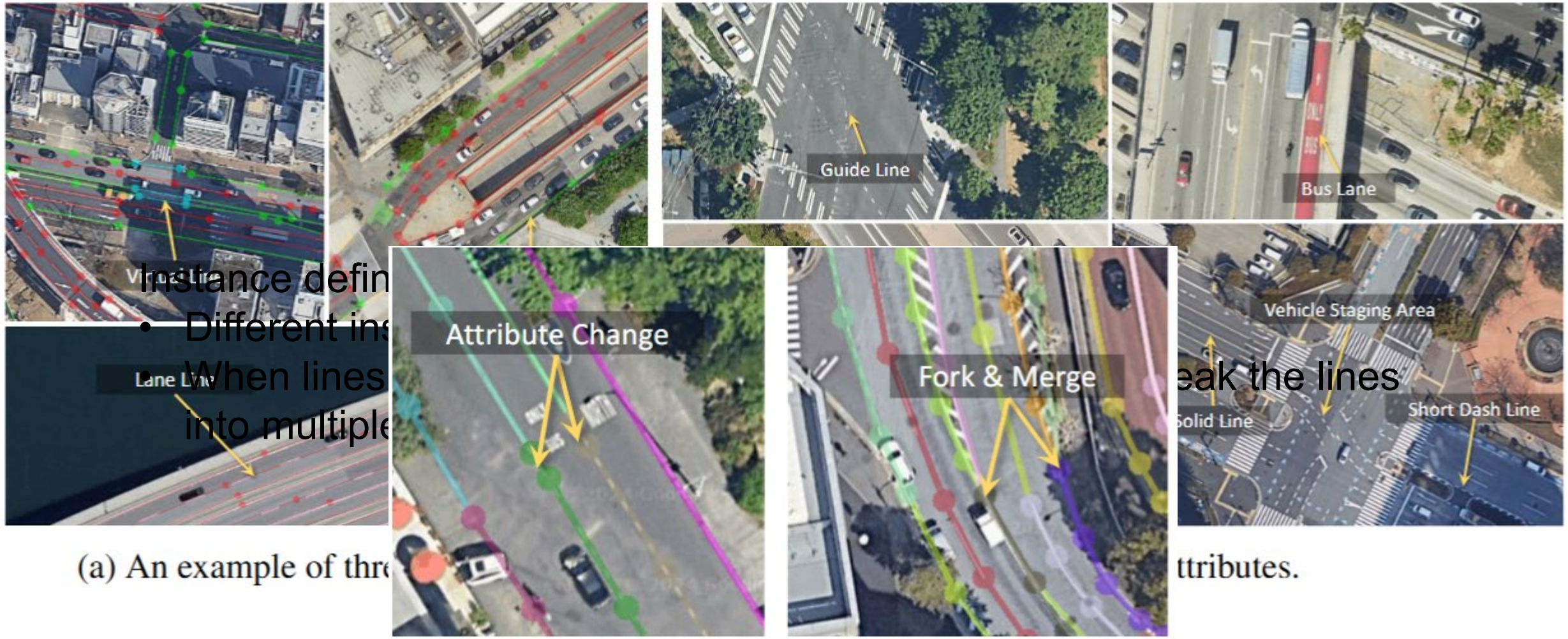
❑OpenSatMap: Data Collection

(a) Landmark correspondences between a satellite image and a nuScenes image.

(b) Overlaying the driving trajectories from the nuScenes dataset onto OpenSatMap (Boston Seaport).

❖ OpenSatMap

❑OpenSatMap: Annotation



Instance defin
- Different ins
- When lines
into multiple

eak the lines

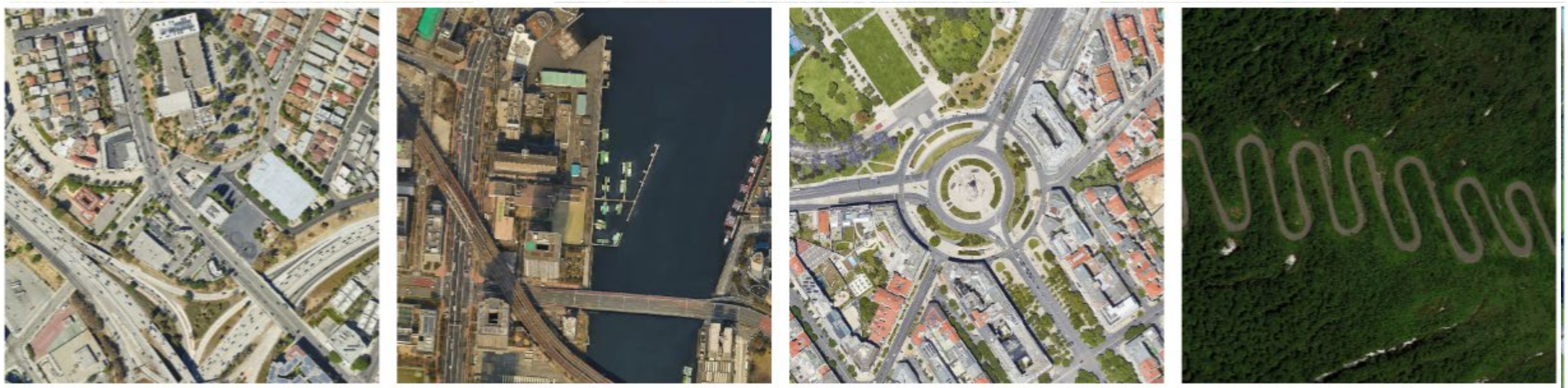
(a) An example of thre ttributes.

(a) Attribute change. (b) Lines fork and merge.

❖ OpenSatMap

❑OpenSatMap: Annotation

Image-level tag



(a) Flyover. (b) Cross-river bridge. (c) Roundabout (d) Winding road.

Figure 4: Special road structure examples.

(a) Urban. (b) Suburban. (c) Rural.

Figure 3: Settlement type examples.

❖ OpenSatMap: Statistics

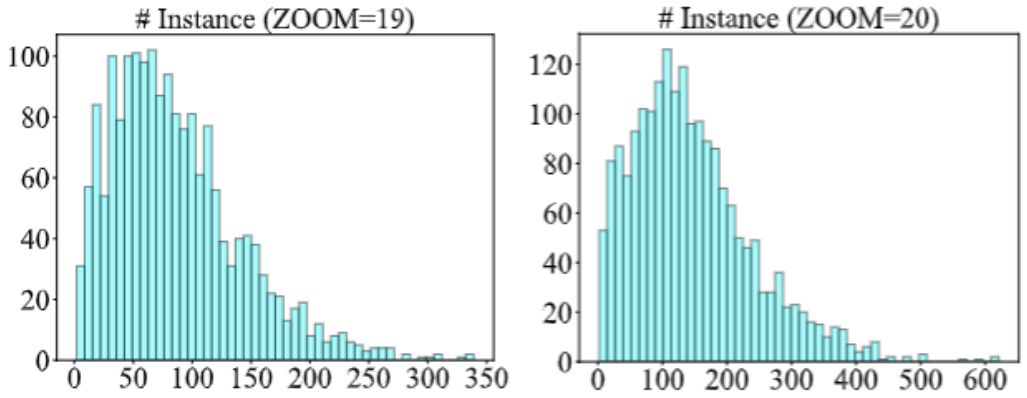


Figure 5: Number of instances in each image in OpenSatMap19 (left) and OpenSatMap20 (right).

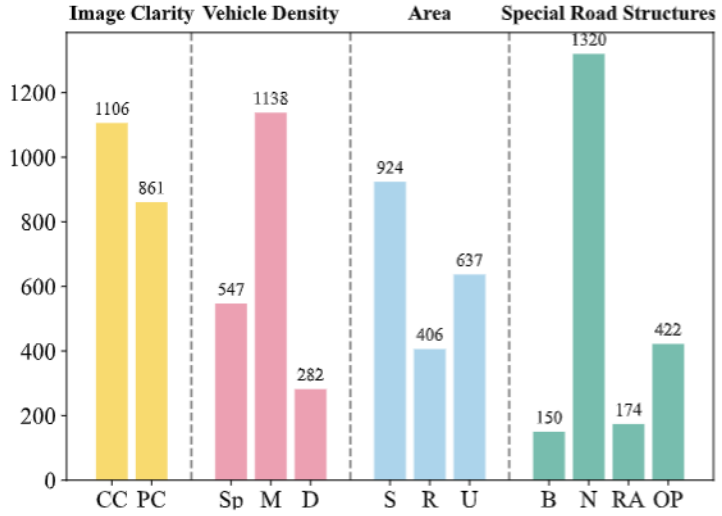
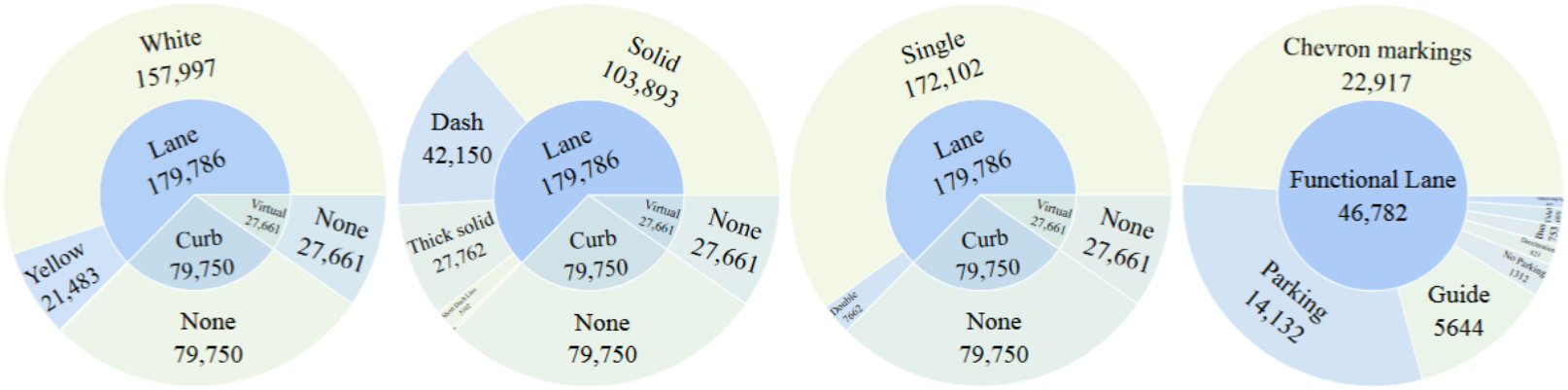


Figure 7: **Image-level tag distribution in OpenSatMap20.** CC = complete clear, PC = partially clear, Sp = sparse, M = moderate, D = dense, S = suburban, R = rural, U = urban, B = bridge, N = None, RA = roundabout, OP = overpass.

❖ OpenSatMap: Statistics

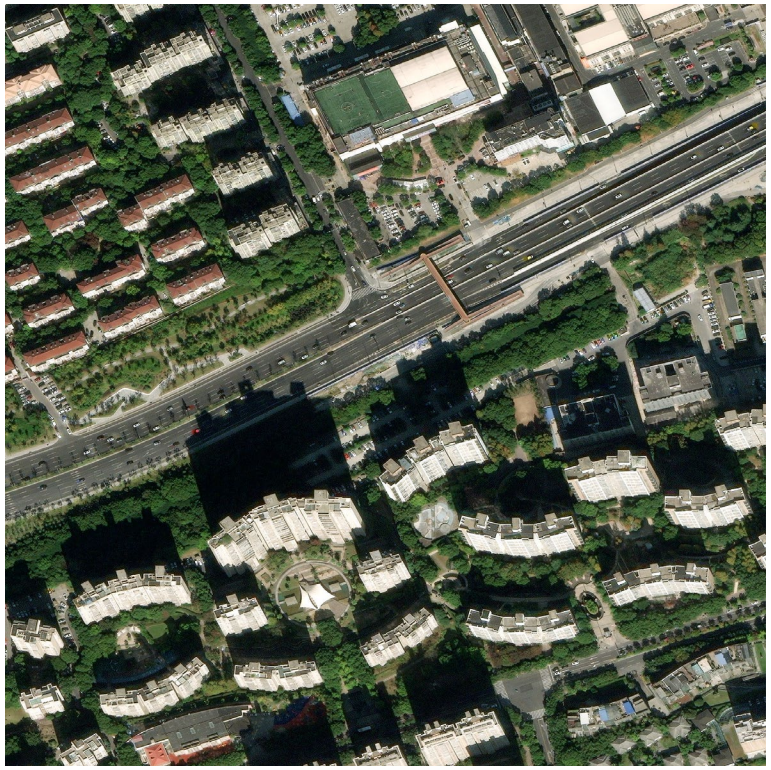


(a) Color distribution. (b) Line type distribution. (c) # lines distribution. (d) Function distribution.

(e) Bidirection distribution. (f) Boundary distribution. (g) Occlusion distribution. (h) Clearness distribution.

❖ Benchmark: Instance-level Line Detection

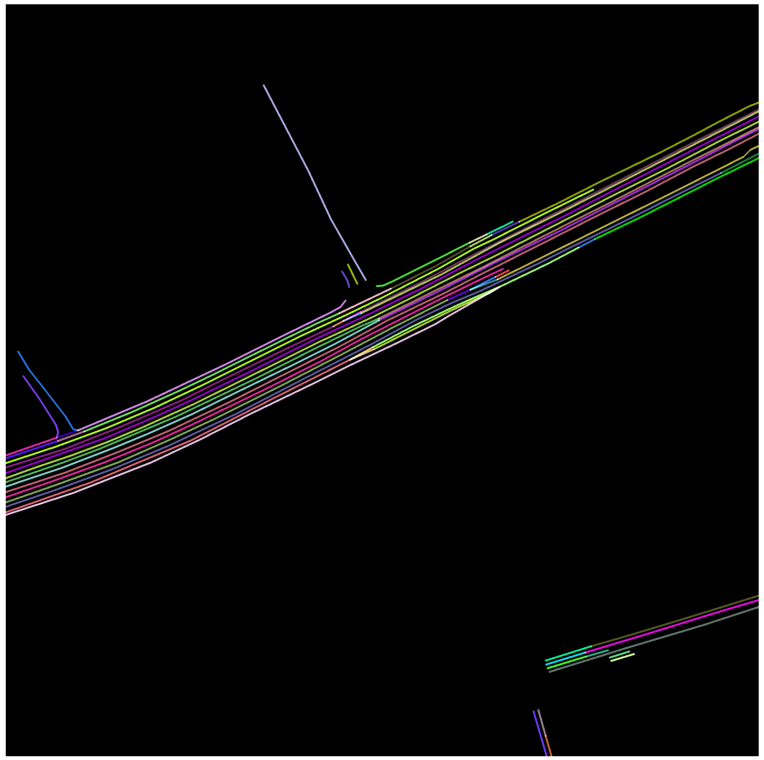
Task Formulation



Input: satellite images

Curve Prediction

Output: Instance-level lines

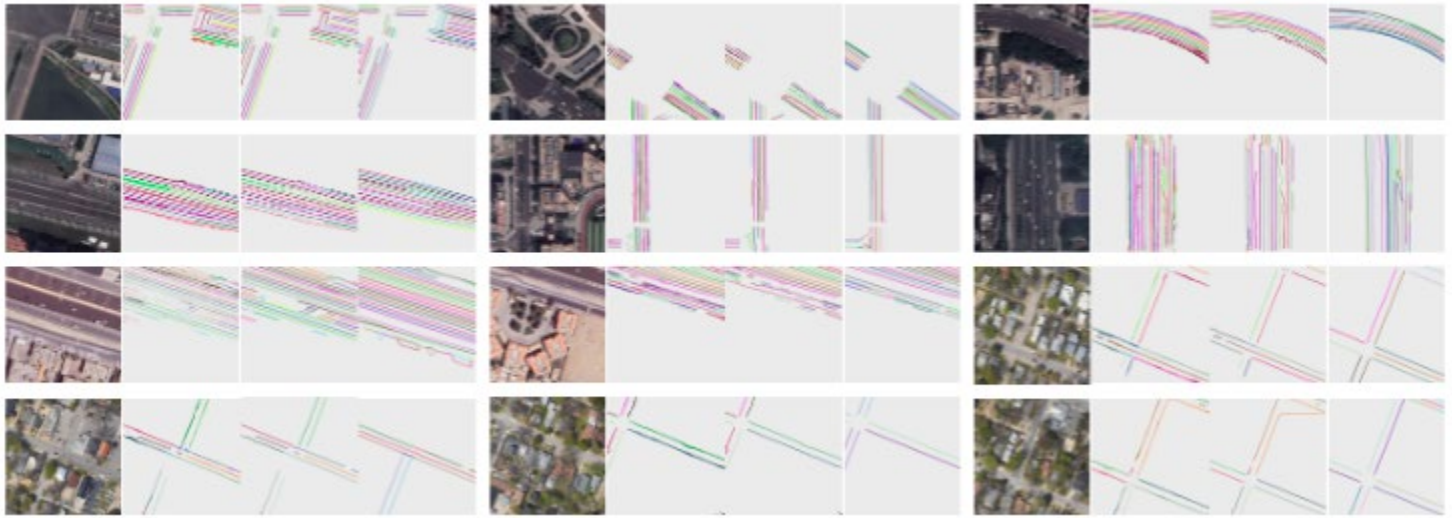


❖ Benchmark: Instance-level Line Detection

❑Evaluation Metrics

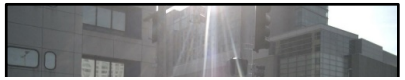
- Mask AP: The same as instance segmentation.
- Chamfer AP:
  - Chamfer distance: $D_{\text{Chamfer}}(\mathbf{p}, \mathbf{q}) = \frac{1}{M} \sum_{i=1}^{M} \min_{j=1,2,\ldots,K} d(p_i, q_j),$

Dataset	$AP^{C}_{0.9}$	$AP^{C}_{1.5}$	$AP^{C}_{3.0}$	$AP^{C}_{4.5}$	$AP^{M}_{50:95}$	AP^{M}_{50}	AP^{M}_{75}	mIoU
OpenSatMap19	$16.04_{\pm 0.35}$	$22.68_{\pm 0.35}$	$26.88_{\pm 0.52}$	$29.18_{\pm 0.22}$	$3.66_{\pm 0.15}$	$10.66_{\pm 0.44}$	$1.45_{\pm 0.12}$	$28.71_{\pm 0.38}$
OpenSatMap20	$20.30_{\pm 0.21}$	$25.93_{\pm 0.35}$	$29.50_{\pm 0.40}$	$31.38_{\pm 0.43}$	$6.98_{\pm 0.21}$	$16.05_{\pm 0.32}$	$5.26_{\pm 0.13}$	$33.69_{\pm 0.45}$

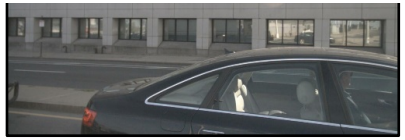


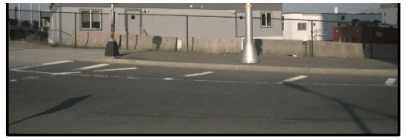
❖ Benchmark: Satellite-enhanced Online Map Construction

We leverage satellite images as an **additional input modality** to enhance online map construction methods.



Method	Divider	Crossing	Boundary	All
HDMapNet [34]	40.6	18.7	39.5	32.9
SatforHDMap [23]	**50.2**	**53.2**	**49.4**	**50.9**






❖ Thanks

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