Leveraging Crowdsourced GPS Data for Road Extraction from Aerial Imagery

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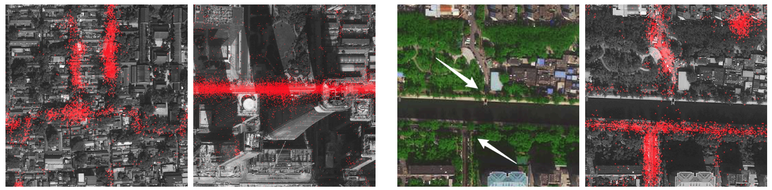
Introduction

AI mapping from satellite imagery has become the reality, replacing the tedious manual work. But mapping from aerial imagery alone has its limitations, such as image occlusion and connectivity issues.

Here we propose to **integrate crowdsourced GPS data** into CNN models to overcome these limitations, which shows at least ~5% boosting in mIoU and ~13% less dropping in predicting new areas, compared with the state-of-the-art methods using either aerial imagery or GPS data alone.

Paper

Typical issues with aerial imagery



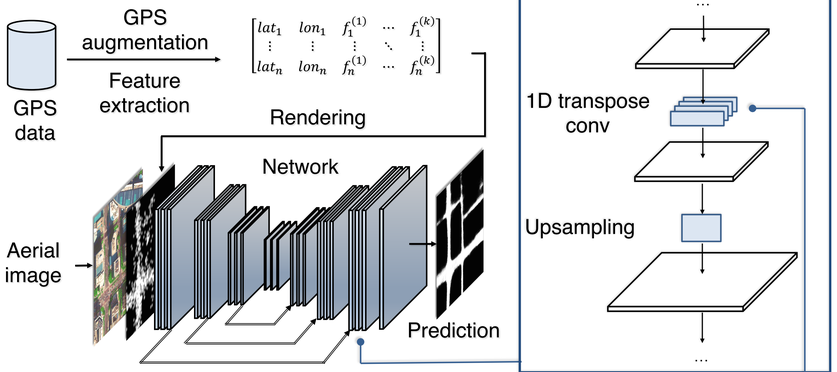
(a) Occlusion by trees, buildings and their shadows

(b) Risk of over connection in post-processing

Typical issues with crowdsourced GPS data

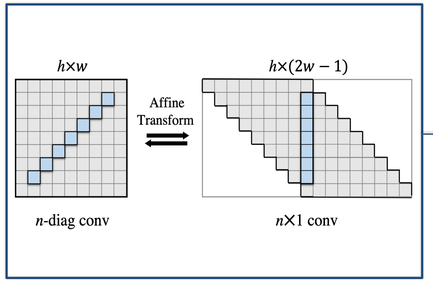
(a) Excessive noise (b) Waiting area (c) Misalignment (d) Outdated data

Architecture

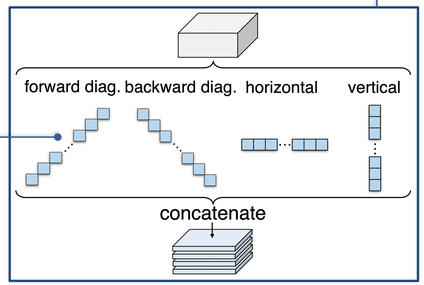


(a) Overall pipeline

(b) 1D decoder block

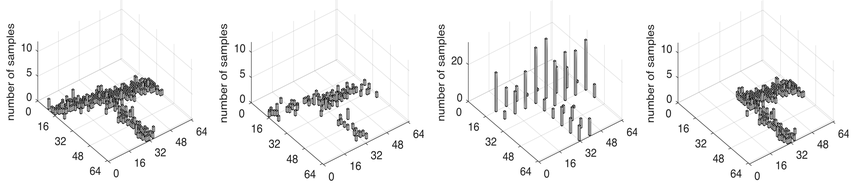


(d) Implementation detail

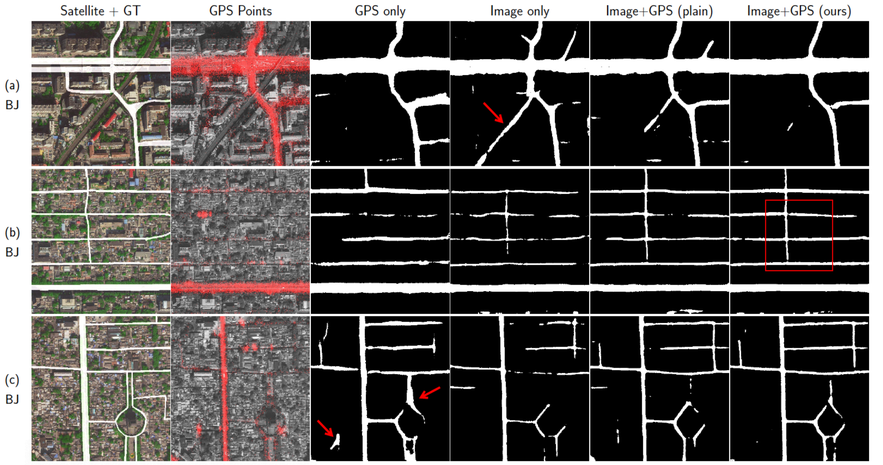


(c) 1D filters of different directions

Data Augmentation of GPS



(a) Original data (b) Subsampling (c) Sub-resolution (d) Random omission



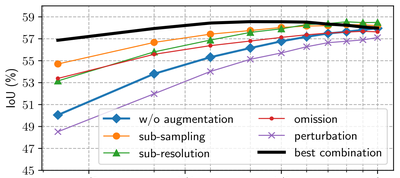
Different input and model combinations

input	method	IoU (%) on *test* set	
		plain	1D decoder
GPS	KDE [9]	34.06	-
	DeepLab (v3+) [8]	47.65	-
	U-Net [24]	43.63	48.10
	Res U-Net [38]	45.33	48.52
	LinkNet [7]	49.98	**51.06**
	D-LinkNet [39]	48.46	49.95
image	DeepLab (v3+)	43.40	-
	U-Net	51.85	52.10
	Res U-Net	50.26	51.77
	LinkNet	53.96	54.84
	D-LinkNet	54.42	**55.15**
image + GPS	DeepLab (v3+)	50.81	-
	U-Net	53.22	54.88
	Res U-Net	52.29	54.24
	LinkNet	57.48	57.89
	D-LinkNet	56.96	**57.96**

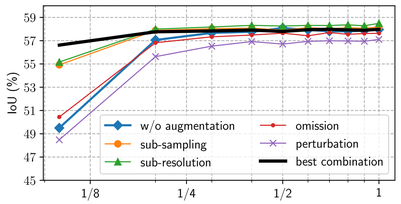
Performance drop of testing new areas

train	method	IoU(%)	relative
Beijing + Shanghai	GPS	44.88	–
	image	55.76	–
	image + GPS (w/o augment)	59.30	–
	image + GPS (w/ augment)	**60.00**	–
Beijing	GPS	42.82	-4.6%
	image	38.16	-31.6%
	image + GPS (w/o augment)	44.57	-24.9%
	image + GPS (w/ augment)	**48.69**	-18.9%

Performance with different GPS quantity



Performance with different GPS resolution



Codes & Dataset

Our GPS dataset is available upon request. Please contact us via suntao@tongji.edu.cn

Codes