Towards Unconstrained Cross-View Pose Estimation

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Introduction

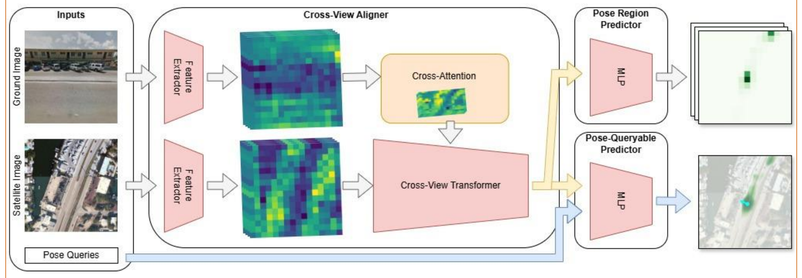
Background

- Cross-View Pose estimation has seen increasing interest in enabling refined localization/orientation of ground images within aerial views for autonomous vehicles, robotics, and within geo-localization.
- Existing work relies on constrained settings/known camera parameters to perform pixel/latent matching to derive the relative camera pose, limiting application with varied imagery

Proposal

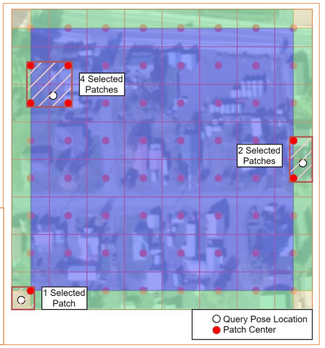
We propose leveraging an attention-based model to implicitly learn ground/aerial –view matching. This extends these models to such less-constrained settings by enabling operation with varied and unknown meta-data—acting as a step towards unconstrained cross-view pose estimation.

Proposed Architecture



Architecture Components

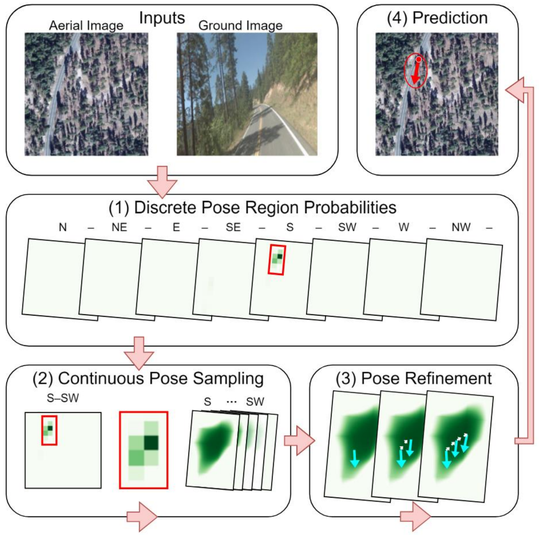
- **Cross-View Aligner**
  Merge cross-view features
- **Pose Region Predictor**
  Generate coarse pose prediction
- **Pose-Queryable Predictor**
  Enable fine-grained prediction



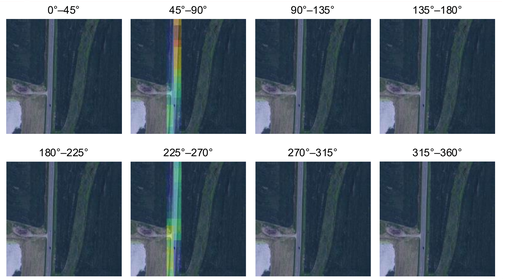
Pose-Queryable Predictor Feature Selection

- Each patch's feature-vector is used for predictions within a local region only
- Select & predict for 'surrounding' features per query—then merge predictions

Proposed Approach



Highlighted Example

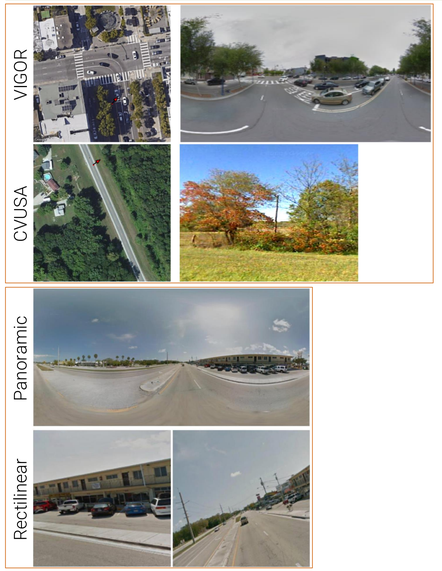


Model predicts strongly (and well!) despite few pixel matches. ***How?***

Observed data biases:

- *Model learns non-matching biases such as terrain likelihood (e.g. road vs non-road locations)*
- *Model learns sun-alignment biases (i.e. Daytime Northern hemisphere imagery → sun roughly in Southern half of sky (even without known/consistent times))*

Results



VIGOR vs CVUSA

Dataset	Method	↓Localization (m) Mean	↓Localization (m) Median	↓Orientation (°) Mean	↓Orientation (°) Median
VIGOR	CCVPE*	8.01	**1.67**	13.22	5.33
	Ours	**5.40**	1.76	**7.87**	**1.68**
CVUSA	CCVPE*	16.56	3.68	51.43	45.68
	Ours	**7.57**	**3.13**	**4.51**	**1.55**

Proj. and H-FoV

	H-FoV	Method	↓Localization (m) Mean	↓Localization (m) Median	↓Orientation (°) Mean	↓Orientation (°) Median
Panoramic	360	CCVPE*	8.01	**1.67**	13.22	5.33
		Ours	**5.40**	1.76	**7.87**	**1.68**
	180	CCVPE*	13.53	3.73	24.03	7.57
		Ours	**5.86**	**1.82**	**8.72**	**1.73**
	90	CCVPE*	21.12	14.11	43.16	16.14
		Ours	**6.04**	**1.88**	**8.89**	**1.76**
Rectilinear	90	CCVPE*	15.36	4.74	37.72	8.95
		Ours	**9.12**	**2.81**	**13.40**	**2.63**
	60	CCVPE*	16.86	7.62	50.83	14.48
		Ours	**9.87**	**3.70**	**17.07**	**2.62**
	30	CCVPE*	18.14	9.82	60.72	24.52
		Ours	**10.70**	**5.20**	**18.09**	**2.79**

Pitch and Roll Variability

Pitch	Method	↓Localization (m) Mean	↓Localization (m) Median	↓Orientation (°) Mean	↓Orientation (°) Median
±0°	CCVPE*	15.36	4.74	37.72	8.95
	Ours	**9.12**	**2.81**	**13.40**	**2.63**
±10°	CCVPE*	16.98	7.93	49.27	14.58
	Ours	**9.62**	**3.53**	**16.10**	**2.76**

Roll	Method	↓Localization (m) Mean	↓Localization (m) Median	↓Orientation (°) Mean	↓Orientation (°) Median
±0°	CCVPE*	15.36	4.74	37.72	8.95
	Ours	**9.12**	**2.81**	**13.40**	**2.63**
±20°	CCVPE*	17.27	8.19	51.55	15.61
	Ours	**9.18**	**3.22**	**16.16**	**2.63**

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