Visualizing Spectral Bundle Adjustment Uncertainty

Kyle Wilson
Washington College

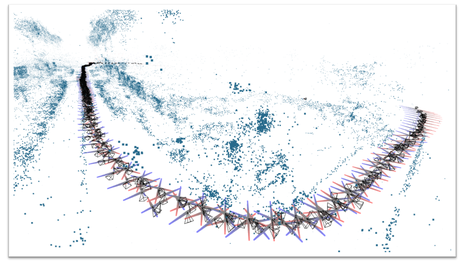
Scott Wehrwein
Western Washington University

The largest modes of uncertainty in a bundle adjustment model are global, not local.

Visualize them by finding and vibrating the dominant eigenvectors of the covariance matrix.

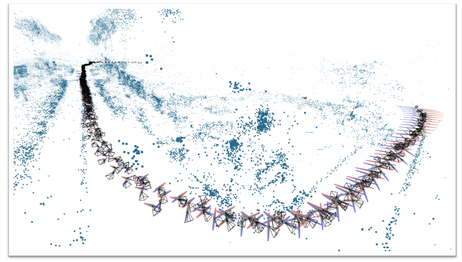
https://wilsonkl.github.io/sfmflex-release/

Try our interactive web-based animations!

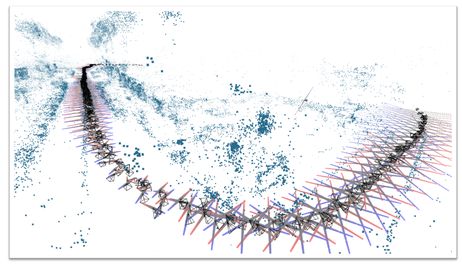


Each image shows one mode of uncertainty.

We visualize each mode as a vibration.

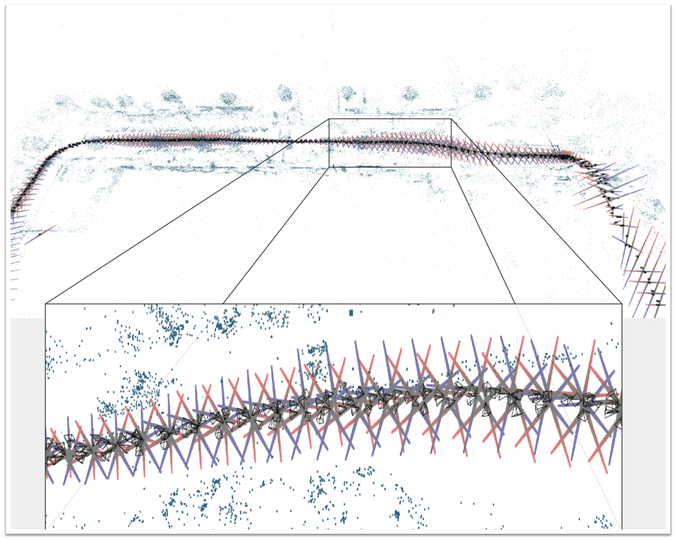


Colored lines show the direction and phase of motion.



These can reveal the underlying structure and challenges in a scene.

Modes are best viewed as animations.



Contribution: scheme to solve for covariance eigenvectors

Challenge: reasoning about the 7D gauge ambiguity

Challenge: numerics / accuracy

Challenge: no natural choice of norm on $\mathfrak{se}(3)$ for eigenvectors

Contribution: animated visualization scheme

$$\mathcal{X}(t) = \mathcal{X} \exp[(A \sin \omega t)\mathbf{v}]$$

$\mathcal{X} \in \mathrm{SE}(3)^n$: a bundle adjustment solution
$\mathbf{v} \in \mathbb{R}^{6n} \equiv \mathfrak{se}(3)^n$: a covariance eigenvector
$\exp$: the tangent space-to-manifold map on $\mathrm{SE}(3)$
A, ω : visualization parameters