Global Solvers for 3D Vision: Foundations, Frontiers, and a Call to the Robotics Community

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Survey Spotlight

"Advances in Global Solvers for 3D Vision"

The **first systematic review** of global solvers in geometric vision.

400+	3	10	60+
papers	paradigms	tasks	years

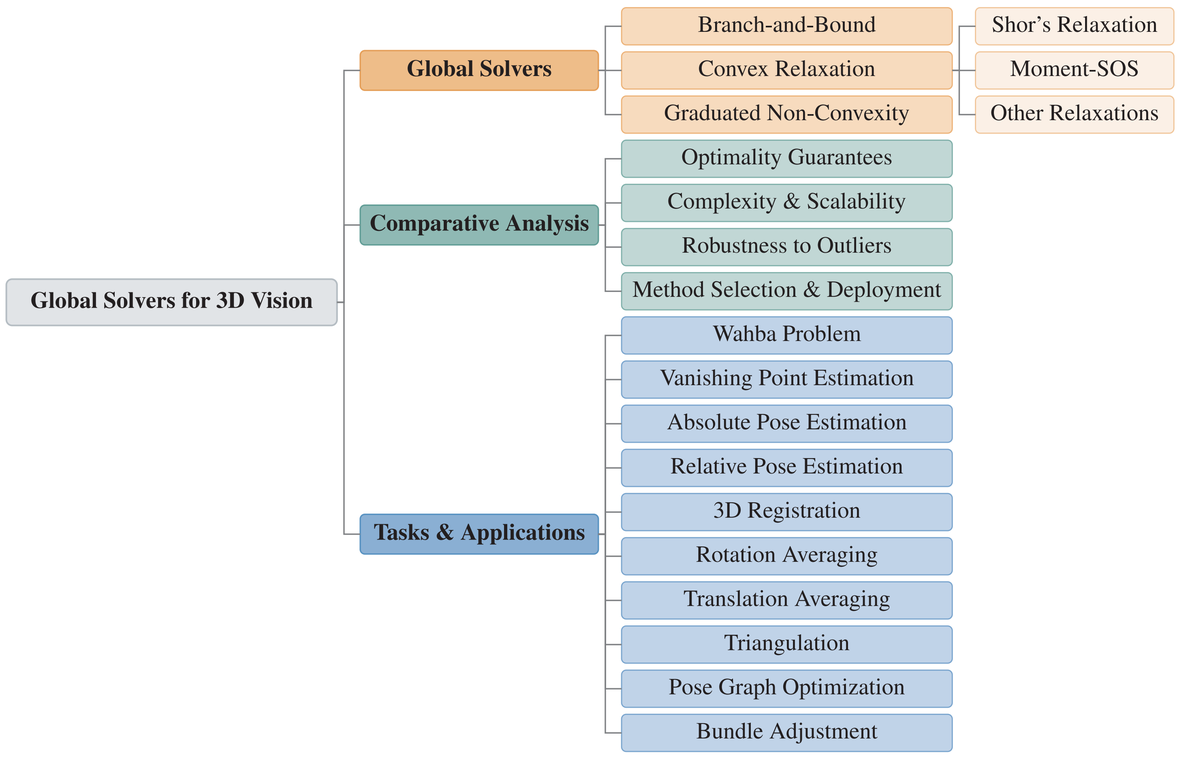
Why Global Solvers? Why Now?

Safety-critical robotics scales up. Autonomous driving, surgical robotics, aerial navigation demand **provably correct** estimation.

Foundation models expose a gap. DUSt3R and VGGT produce impressive outputs. But **impressive ≠ certifiably globally optimal**.

The tools are ready. SDP solvers, differentiable relaxations, and scalable algorithms exist. **The community needs to engage.**

Taxonomy of Global Solvers

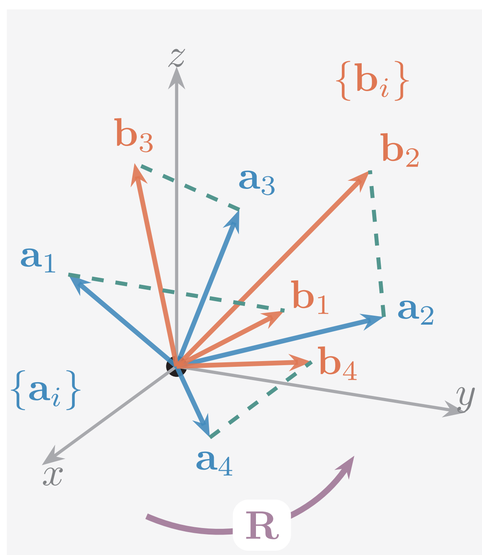


Which Solver Should You Use?

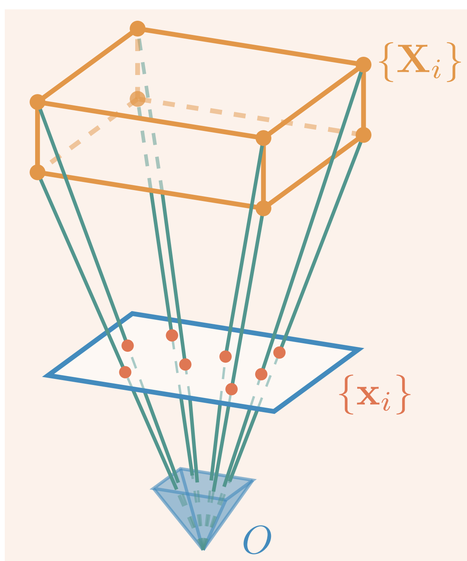
METHOD	OPTIMALITY	SCALABILITY	OUTLIER HANDLING	COMPLEXITY	CERTIFICATES
Branch & Bound BnB	✓ Global	✗ Poor $N<20$	↪ Consensus Max (CM)	△ Exponential in dim	✓ Always
Shor's Relaxation Convex Relaxation	♦ Global if tight	● Medium 100–1k	→ M-est robust	▷ $O(n^{3.5})$ SDP	♦ If tight
Moment-SOS Lasserre Hierarchy	♦ Global if tight	✗ Low $N<100$	↪ CM + M-est	△ $O(r^{3.5})$ grows fast	♦ If tight
Other Relaxations L_∞ / SOCP / LP / QP	≈ Near-global prob. spec.	⇑ High $N>1k$	● Problem specific	⇒ $O(n^3)\sim O(n)$ fast	● Prob. specific
GNC Grad. Non-Convexity	~ Near-global no cert.	★ Excellent $N>1k$	▲ Built-in 30–50%	⇒ $O(Kn^2)$ linear N	✗ None

● Strong ♦ Good / Conditional ● Moderate ● Limited

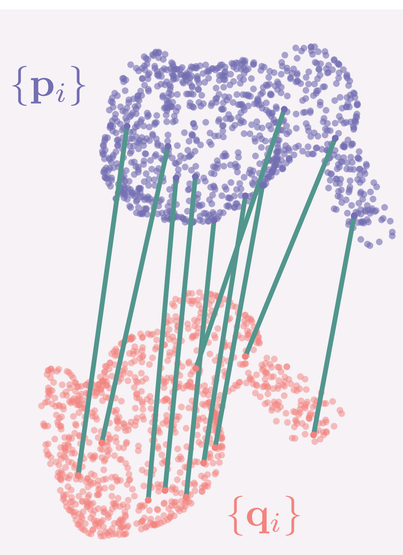
Representative Geometric Estimation Tasks



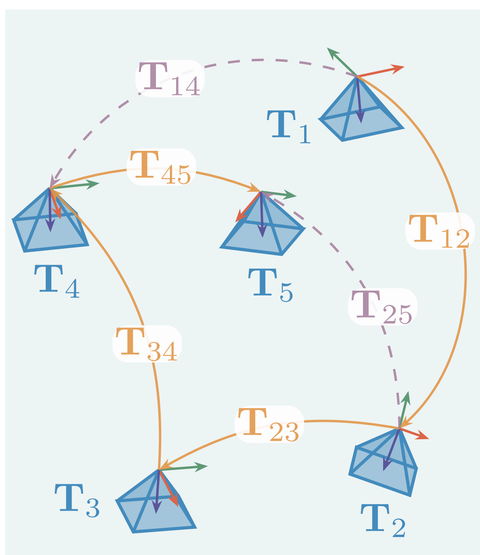
Wahba Problem



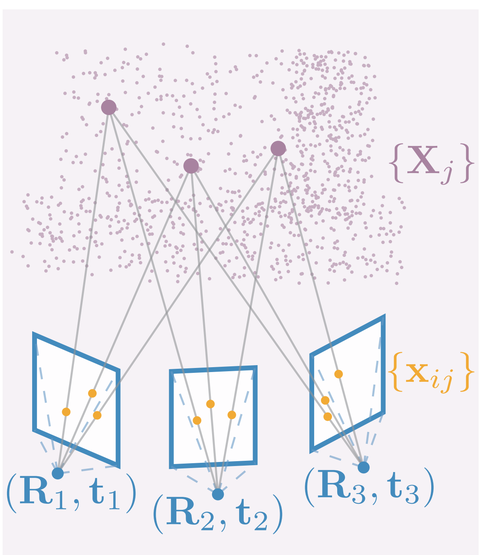
Absolute Pose Estimation



3D Registration



Pose Graph Optimization



Bundle Adjustment

Open Challenges

Scalability

BnB and CR costs grow prohibitively with problem size.

Open: Hybrid pipelines pairing fast GNC with lightweight certifiers.

Deep Learning Integration

Foundation models produce impressive predictions without certificates.

Open: CR as differentiable layers and learned priors to warm-start solvers.

Standardized Evaluation

The field lacks shared benchmarks enabling fair comparison.

Open: Certified optimality rate, tightness gaps, runtime-accuracy curves.

Resources & Contact

GitHub Repo
Star us!

Survey Paper
arXiv:2602.14662

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