Efficient and Singularity-Robust Inverse Kinematics and Redundancy Resolution for 6- and 7-DOF Manipulators

IK-Geo: Subproblem Decomposition Inverse Kinematics

Fastest general IK solver based on published literature

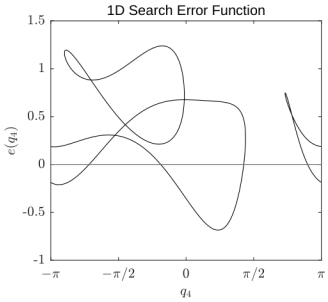
Closed-Form 6-DOF Solutions

Any 3 intersecting or parallel axes

$+ \; - \; \times \; \div \; \sqrt{} \; \sqrt[3]{}$

1D Search 6-DOF Solutions

Any 2 intersecting or parallel axes
Includes non-consecutive intersecting axes



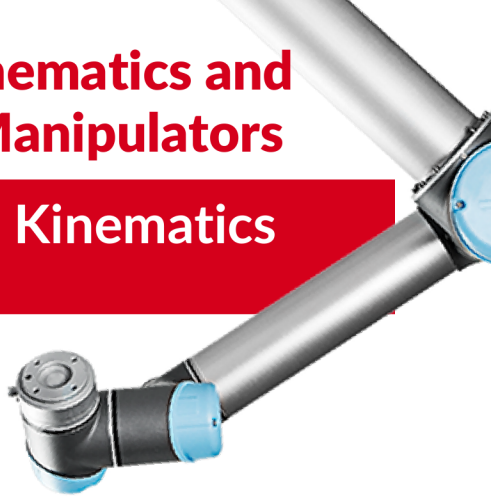
All industrial arms have some intersection

2D Search 6-DOF Solutions

General case

>40x faster

IK for UR5 vs IKFast



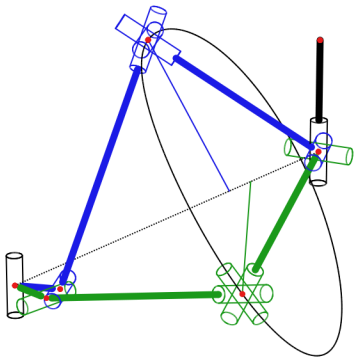
- Robust to singularities (boundary and internal)
- Returns all solutions
- Returns continuous approximate solutions
- Compatible with 7-DOF and parallel robots
- Easy to find tangent half-angle polynomial
- Open source: C++, Rust, MATLAB, Python
- Easy to port and modify

Stereographic SEW Angle

Parameterize 7-DOF arms without algorithmic singularities in the workspace

Shoulder-Elbow-Wrist (SEW) angle

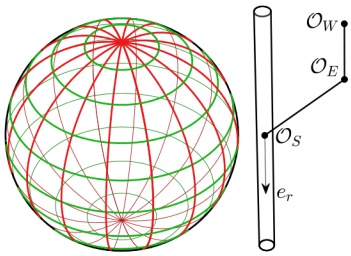
Parameterizes 7-DOF redundancy
AKA arm angle, swivel angle



How to choose reference angle?

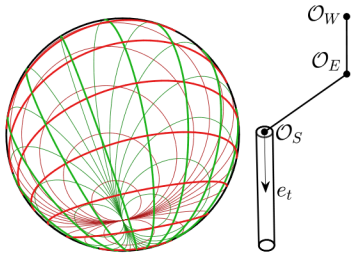
Conventional SEW

Singularity on full line



Stereographic SEW

Singularity on half-line



Singularity can be placed in ground out of reach

- Compatible with IK-Geo
- Compatible with existing algorithms
- Jacobian provided

Learn More

`linktr.ee/automate_ik`

- GitHub
- Videos
- Demos
- Papers

Alex Elias
PhD Candidate
`eliasa3@rpi.edu`
Rensselaer Polytechnic Institute
Booth #5674

Rensselaer200