

6R Robots and their Inverse Kinematics via Monodromy

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Goal: Inverse Kinematics Problem

Given a position and orientation for the hand, find joint angles that realize it

Denavit-Hartenberg Parameters

The Denavit-Hartenberg parameters attach a coordinate system to every joint inductively







Figure 2: Denavit-Hartenberg Parameters

The Monodromy Action

Solution space sits over parameter space as a branched covering

Loops at a given point in the base space act on its fibre, and this action is called **monodromy**

Method

Cast the IKP as a system of polynomial equations and solve generic case using monodromy

Utilize homotopy tracking to specialize generic solution to given parameters



Figure 3: Monodromy example



Figure 4: Homotopy Tracking

Galois Theoretic Data (in progress)

Solution by monodromy action associates to each robot a Galois group as follows:

 $Gal((\mathbb{C}(\boldsymbol{p})[\boldsymbol{x}] / < f(\boldsymbol{x}, \boldsymbol{p}) >) / \mathbb{C}(\boldsymbol{p})) \cong \phi(\pi_1(\mathcal{P}, \boldsymbol{p_0}))$

Project next steps will be to study such Galois groups and the implications of their structure for specific robots

Acknowledgements

This project was supported by the NSF grants #1745583, #1851843, #2244427 and the GaTech College of Sciences. We would like to thank our mentor professor Leykin for his support in completing this project.

Figure 1: Kuka KR-15/2 Robot