

Homotopy Continuation and Monodromy

A loop in the parameter space corresponds to a path in the solution space.

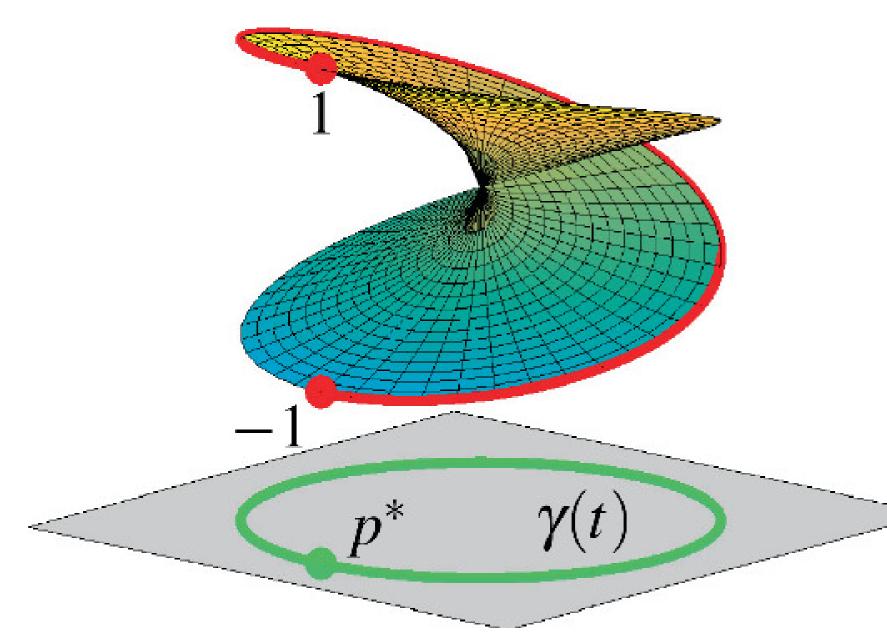


Figure 1. Monodromy yielding a new solution

An Application: Pose Determination

- Given the location of some primitives—points, lines, and conics—in the world and their projections on the image plane of a calibrated camera, we recover the location of the camera.
- This situation arises in augmented reality (virtual fitting rooms), AI-driven fitness, online physiotherapy, and crime investigation.

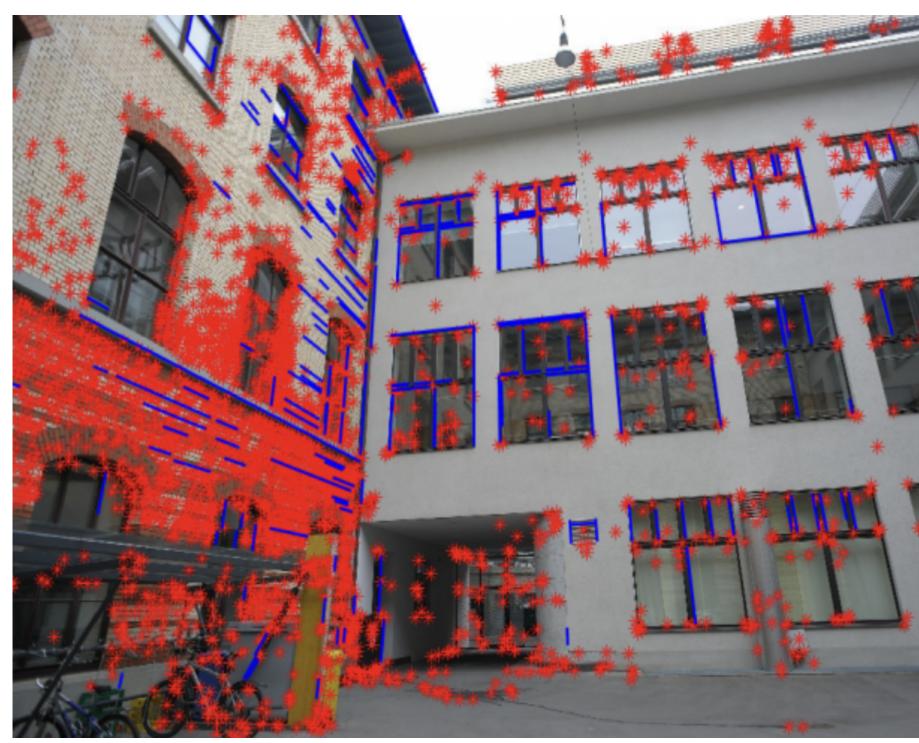


Figure 2. Point-line correspondences

Pose Determination with Conics

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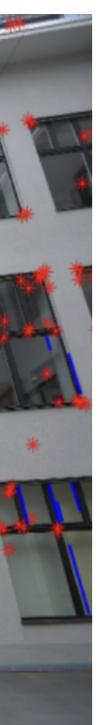
- Most of the previous work studies point-line correspondences, although they are less abundant in images than conics and their extraction is less reliable than that of conics.
- De Ma, 1997: The camera's pose can be recovered given 2 conics.
- Wang, 2013: The camera's pose can be recovered linearly given 3 conics.

Main Question

- Given: the location of m conics in the world; and their images (also conics) on the image plane of a camera.
- What is the minimum number of conics *m* necessary to recover the location of the camera, that is, the matrix

$$\begin{bmatrix} & & t_1 \\ R & t_2 \\ & & t_3 \\ \hline 0 & 0 & 0 & 1 \end{bmatrix} \in \mathbb{S}$$

relating the world and image coordinate systems?



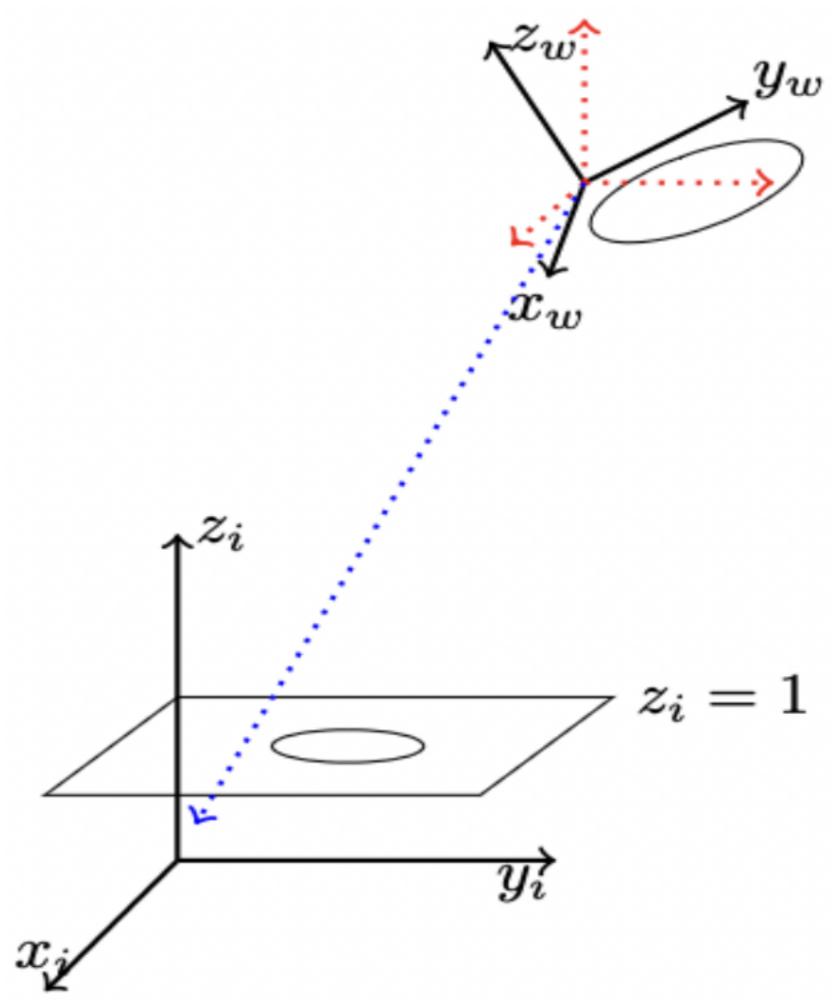


Figure 3. Setting up the problem

Previous Work

 $\mathbb{SE}(3)$

Reformulating with Projective Geometry

Considering a conic and its dual gives us double the information.

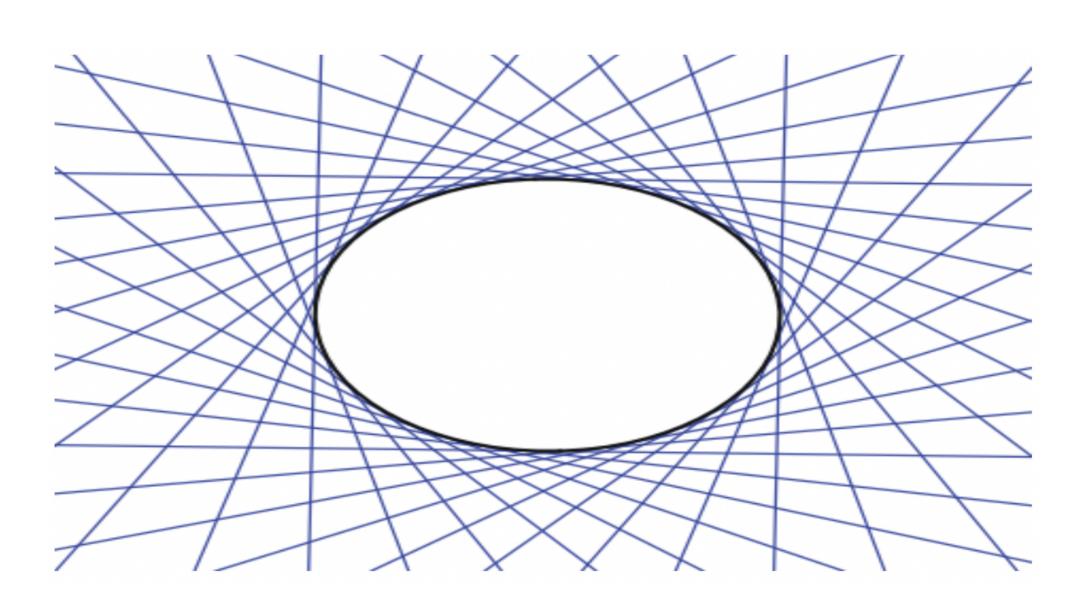


Figure 4. A conic and its dual

Theorem (Barton-Muthuvel)

The polar of any point lying on the plane of the conic is invariant under projective transformation.

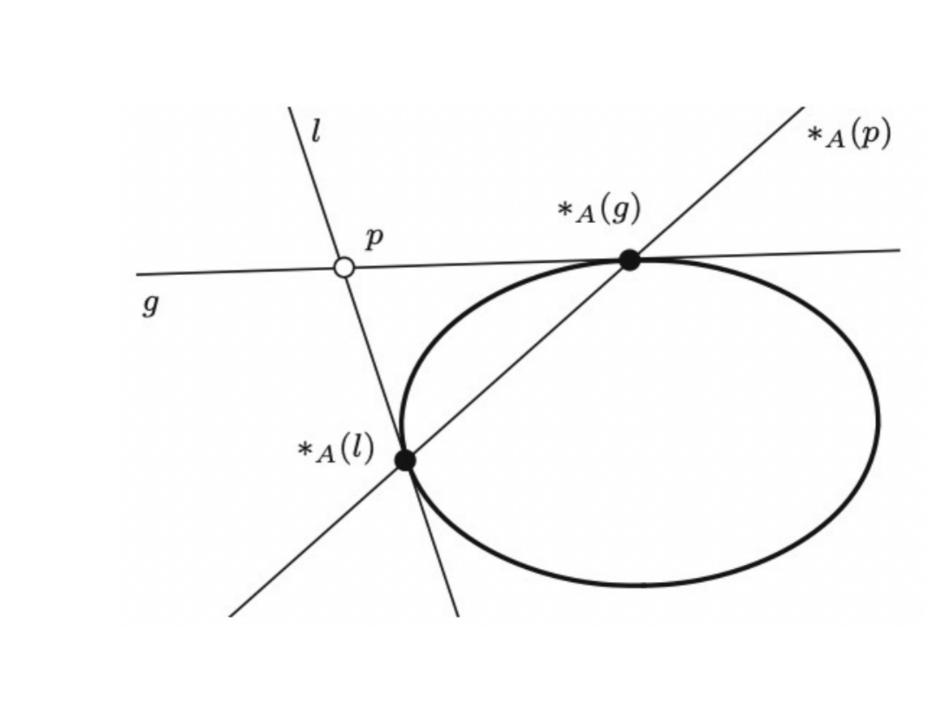


Figure 5. Properties of polars

Next Step \implies Conjecture

The location of the camera can be recovered given m = 1 conics.

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