Pose Determination with Conics
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## 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), Al-driven fitness, online physiotherapy, and crime investigation.


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## Previous Work

- 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
$\left[\begin{array}{cc|c} & & t_{1} \\ & & t_{2} \\ & & t_{3} \\ \hline 0 & 0 & 0 \\ \hline\end{array}\right] \in \mathbb{S E}(3)$
relating the world and image coordinate systems?


Figure 3. Setting up the problem

## 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 $\Longrightarrow$ Conjecture

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

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[^0]:    Figure 2. Point-line correspondences

