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Tutorial: Statistical Methods in Projective Geometry for Image Analysis

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Projective Geometry has been a successful research area in Computer Vision within the last decade and has shown to play an important role in image analysis. It provides not only a consistent and easy representation of geometric entities such as points, lines and planes, but also for the camera geometry of single and multiple views.
In this tutorial we will give an introduction into projective geometry, present a toolbox for uncertain geometric reasoning as a basis for new orientation procedures in photogrammetry. These cover explicitly the orientation of one, two and three cameras.They refer to calibrated, to straight line preserving and to general camera models and can also be used for analysing laser range data to advantage. They cover points and lines as basic observations and finally handle uncertain geometric
entities including orientation parameters.
The goal is to show that projective geometry eases the setup of quite complex geometric estimation procedures without loosing the rigor and experience of classical photogrammetric orientation procedures. We concentrate our presentation on the following topics:

- Representation of points, lines and planes in 2D and 3D by homogeneous vectors and matrices
- Euclidean interpretation of homogeneous entities
- Direct Construction of new geometric elements
- Testing geometric relations between elements
- Projections for points and lines and inverse projection
- Orientation of one and two images

The introductory tutorial is meant for all researchers and developers who are interested in the analysis of uncertain geometric entities in 2D and 3D, especially in the context of photogrammetric orientation and calibration. Basic knowledge in linear algebra and statistics is recommended.