IACV Topics for full Projects 2024-2025

F01. Rectification using homotopy continuation

(luca.magri@polimi.it)

In several scenarios, the rectification of an image using the image of the circular points is not always feasible due to numerical instabilities. This project explores the application of **homotopy continuation** techniques for image rectification and investigates whether this method is more robust with respect to standard numerical and symbolic solvers.

F02. Reconstructing drone trajectories and cameras from multiple images

(luca.magri@polimi.it)

This project focuses on solving the challenging task of reconstructing drone trajectories and camera poses using datasets from the Drone-Tracking Project. The input consists of unsynchronized videos captured from multiple moving cameras observing a drone. The objective is to recover the 3D trajectory of the drone and the relative poses of the cameras over time.
https://github.com/CenekAlbl/drone-tracking-datasets

F03. Reconstruction of algebraic curves

(luca.magri@polimi.it)

This project explores the 3D reconstruction of 2D algebraic curves using projections from multiple views. Algebraic curves are described as the zero set of polynomial equations, and their 3D reconstruction involves recovering the spatial representation of a curve based on its 2D projections.
https://www.cs.huji.ac.il/w~shashua/papers/Jeremy-IJCV-final.pdf

F04. Single-image sphere reconstruction

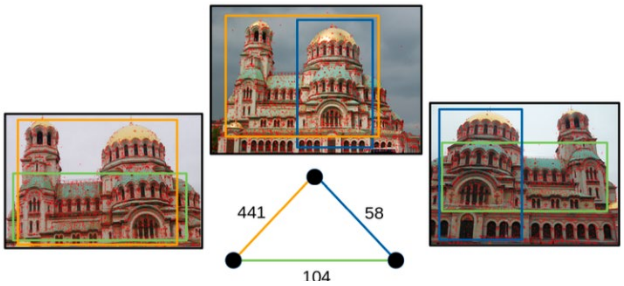
(luca.magri@polimi.it)

This project focuses on implementing a computer vision method for reconstructing a 3D sphere from a single 2D image, based on the approach detailed in the paper "Reconstructing Spheres by Fitting Planes".
The project also explores potential extensions of the technique to generalize the reconstruction process to other geometric shapes, such as ellipsoids, to enhance its applicability in diverse scenarios.

F05. Optimizing the viewing graph

(federica.arrigoni@polimi.it)

The viewing graph is a graph such that: each node represents one image (or, equivalently, one camera); an edge is present between two nodes if the fundamental (or essential matrix) between those cameras is available (which in practice derives from the fact that there are enough correspondences between the two images). In this context, a relevant problem is how to sparsify an initial graph such that bad edges are removed.



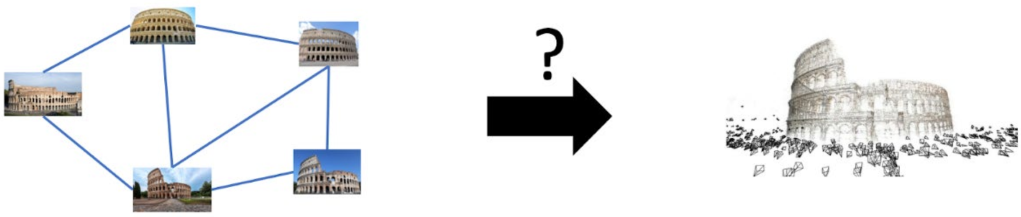
The goal of this project is to provide a critical review of the approach presented in [1], analyzing advantages/disadvantages with respect to other methods, and proposing possible improvements, such as how to extend the approach to manage general graphs not covered by triplets.

[1] Manam and Govindu. *Leveraging Camera Triplets for Efficient and Accurate Structure-from-Motion*. CVPR 2024
https://ee.iisc.ac.in/cvlab/research/camtripsfm/

F06. Theoretical analysis of the viewing graph

(federica.arrigoni@polimi.it)

The viewing graph [1] is a graph such that: each node represents one image (or, equivalently, one camera); an edge is present between two nodes if the fundamental matrix between those cameras is available (which in practice derives from the fact that there are enough correspondences between the two images). By studying the viewing graph, it is possible to derive important theoretical properties of 3D reconstruction. Specifically, it is possible to establish if a problem is well-posed (or “solvable”) in the sense that there exists a *unique* reconstruction of uncalibrated cameras.



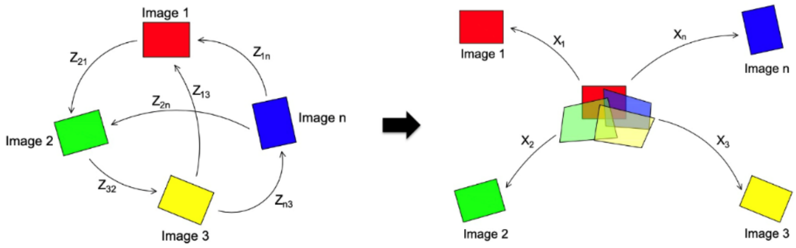
The goal of this project is to analyze the solvability of small viewing graphs by implementing the results presented in [1].

[1] Levi & Werman. *The viewing graph*. CVPR 2003

F07. Synchronization of Projective Transformations

(federica.arrigoni@polimi.it)

Synchronization refers to the problem of estimating absolute transformations starting from pairwise ones. In the case of projective transformations, the scale ambiguity must be taken into account. Image mosaicking can be viewed as an example of synchronization: in this case, the transformations are 3x3 matrices representing homographies, used to stitch images into a mosaic.



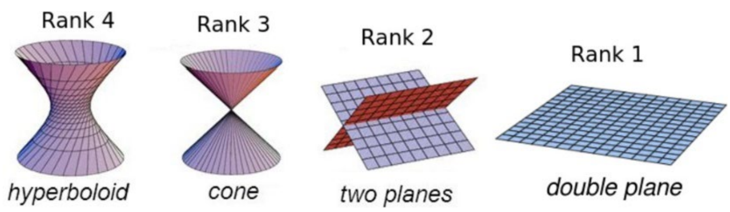
The goal of this project is to implement an algorithm for image mosaicking, by using the recent approach from [1], originally developed for 4x4 transformations, and adapt it to 3x3 matrices. A comparison with [2] must be carried out, identifying the advantages/weaknesses of the two methods.

[1] Madhavan, Fusiello, Arrigoni. *Synchronization of projective transformations*. ECCV 2024
[2] Schroeder, Bartoli, Georgel, Navab. *Closed-form solutions to multiple-view homography estimation*. WACV (2011).

F08. A quantitative measure for critical configurations

(federica.arrigoni@polimi.it)

A configuration of two cameras and 3D points is called critical if there is not a unique fundamental matrix describing their geometry. In this case, fundamental matrix estimation is ill-posed and highly unstable in the neighborhood of the critical configuration. In [1] an analysis is provided where a measure to define this instability is derived from two pre-computed fundamental matrices.



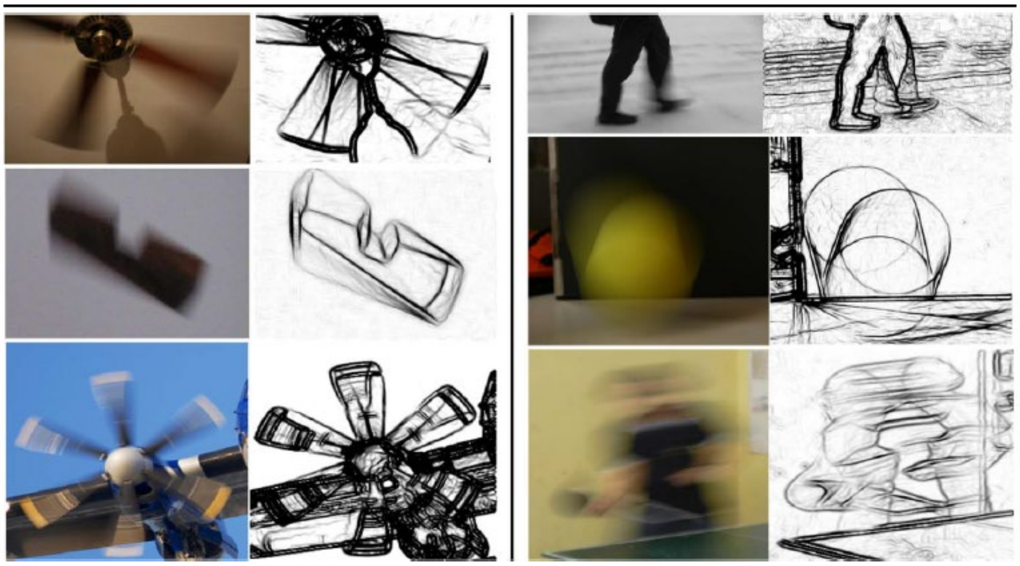
The goal of this project is to turn the theoretical analysis from [1] into an effective measure that can be used to identify critical configurations in practice.

[1] Luong, Faugeras. *The fundamental matrix: theory, algorithms, and stability analysis*. IJCV 1996

F09. Object detection in motion-blurred images

(vincenzo.caglioti@polimi.it)

Analyze motion-blurred image to detect moving objects (see [1]).



[1] V.Caglioti, A.Giusti "On the Apparent Transparency of a Motion Blurred Object" – Int. Journal of Computer Vision, (2010) n. 86: pp. 243–255

F10. Visual analysis of moving vehicles

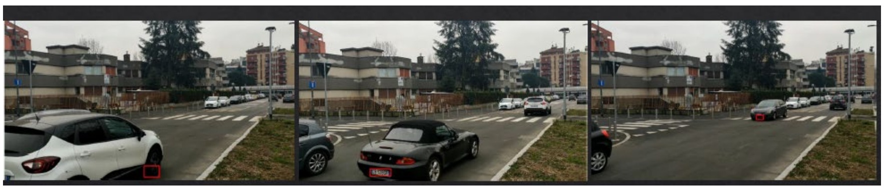
(vincenzo.caglioti@polimi.it)

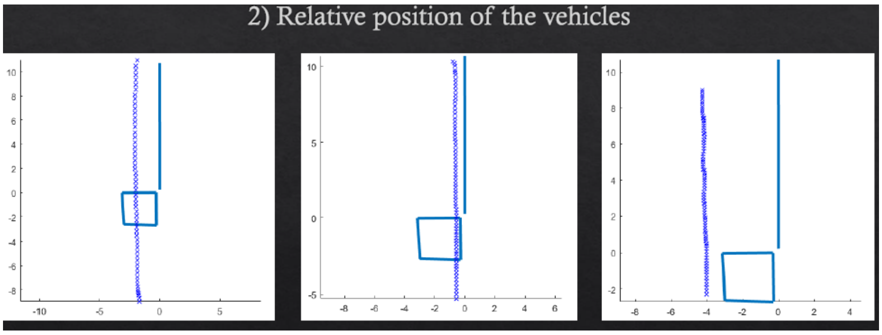
This topic offers different projects:

(i) Visual analysis of moving vehicles (shape, trajectory, speed from time-to-impact etc.)

(ii) Model-based accurate 3D localization vehicles for responsibility attribution in collisions

(iii) Visual analysis from moving vehicles (shape of the environment, ego-motion and relative motion of other vehicles).

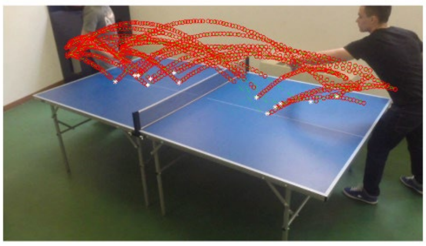


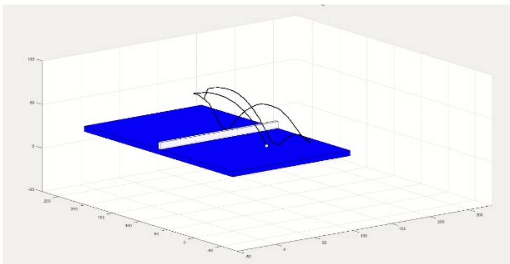


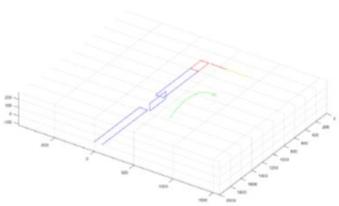
F11. Visual Analysis of Sport Events.

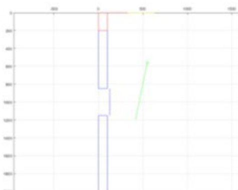
(vincenzo.caglioti@polimi.it)

Visual analysis of sport video in order to determine the 3D trajectory of salient elements (ball, players, racket). Projects dealilng with Bowling, Badminton, Volley, Basket, Waterpolo, Tennis, Tabletennis, Swimming etc. are welcome.









F12. Visual reconstruction of played music

(vincenzo.caglioti@polimi.it)

Try to determine the pressed keys of a keboard instrument (e.g., accordion, piano, organ, bandoneon) through the visual analysis of both fingers and keyboard.