The MOVI Adventure
A Decade of Computer Vision in the 90’s

10/11/2022

The starting point

The key point

In 1988, Radu convinces Roger Mohr to leave Nancy and to come to Grenoble

Together, they create the new team MOVI!

The team took place in the LIFIA lab, in the IMAG institute…

Start of a lot of European Projects: First, Second, Third, Viva…

And collaborations: A. Zisserman, L. Van Gool, H.H. Nagel, J. Mundy, R. Hartley…

A Little Bit of History

In 1990

- Labs of computer science have been using mail for several years, but mail was not used elsewhere
- Networks have existed for a long time, Internet dates back to the end of the 80's, The web appeared in 1991-92
- The mainframe was a Vax computer with VMS, the lab had a few workstations with BSD Unix.
- A grad student still worked on something like

The technological background

- Having digital images was difficult : a set of 10 images was a big collection!

- The classical way to process an image :
  - Edge detection
  - Polygonal approximation
  - Segment detection,
  - Organisation of the segments in patterns

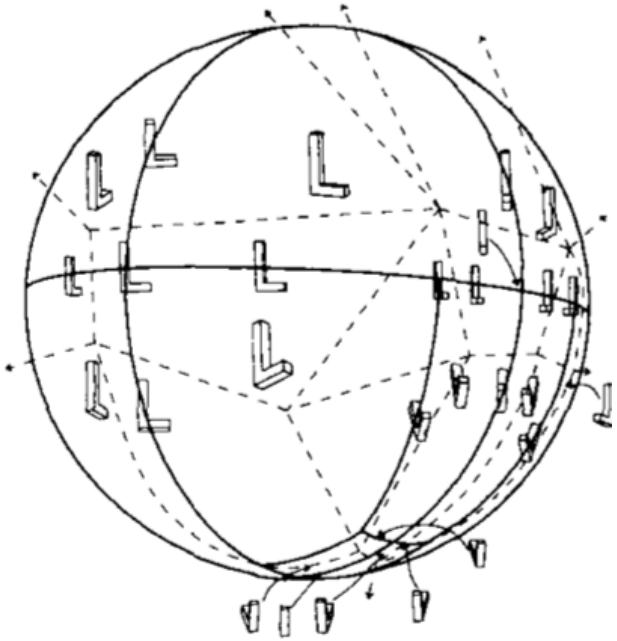
- Computing the edges of a 512 x 512 image took 2mn on a good desktop computer

The theorem of Oxford :

A master is an algorithm that works on one image, a PhD is an algorithm that works on two images!

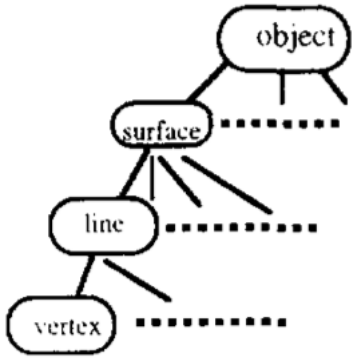
The state of the art in image recognition

- Aspect graphs and CAD-based vision
  - Computing all the possible projections of the edges of an object
  - Find topological classes of projections and their cone of view



  - Too complex for real size objects
  - Impossible to determine what is visible, what is not
  - Many small part give a random texture, not aspects
  - Extremely hard to identify an aspect in an image

- Symbolic description
  - A triangle above a square left of a circle…



  - Impossible to extract from images

The New Era of (Projective) Geometry

A new set of assumptions

- Consider simple pattern in images : image-based recognition
  - No more triangle, squares or rectangles
  - Points, sets of connected segments
- Compute numerical descriptors in images
  - Quasi-invariants, invariants
- Use global geometric constraints
  - 2D motion between 2 images
- Consider the projective model of a camera
  - Epipolar geometry
- Applications to robotics – grasping and manipulation

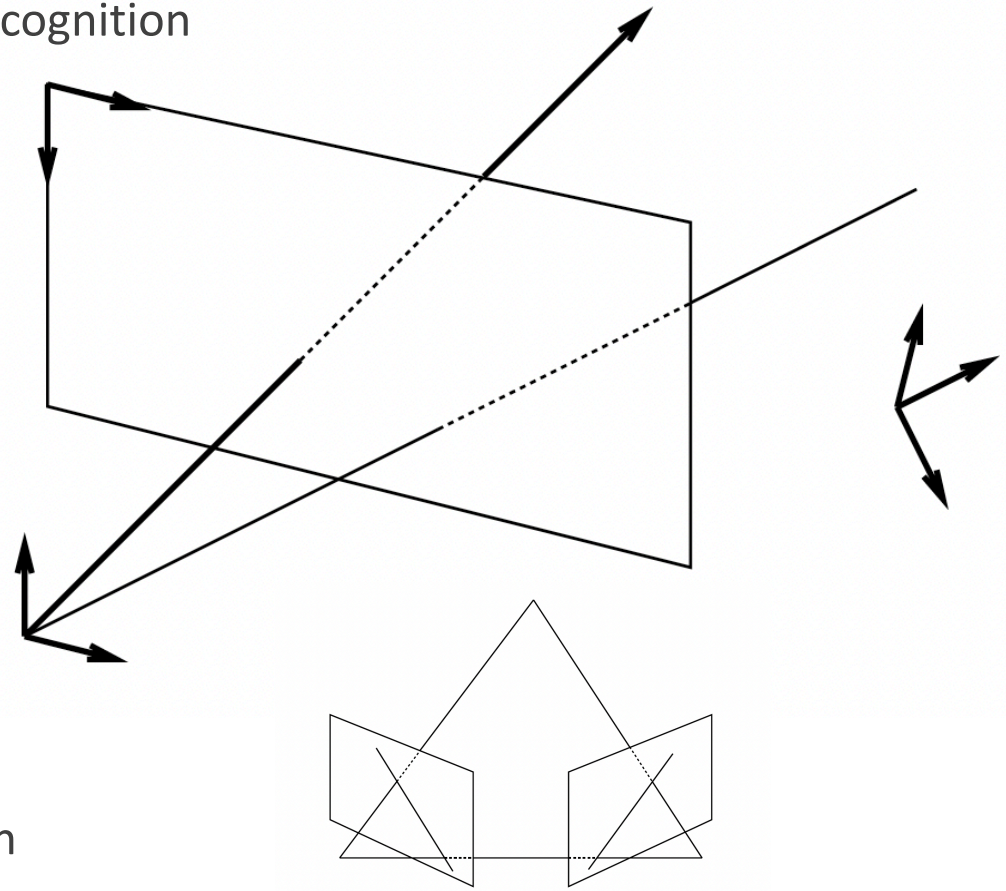
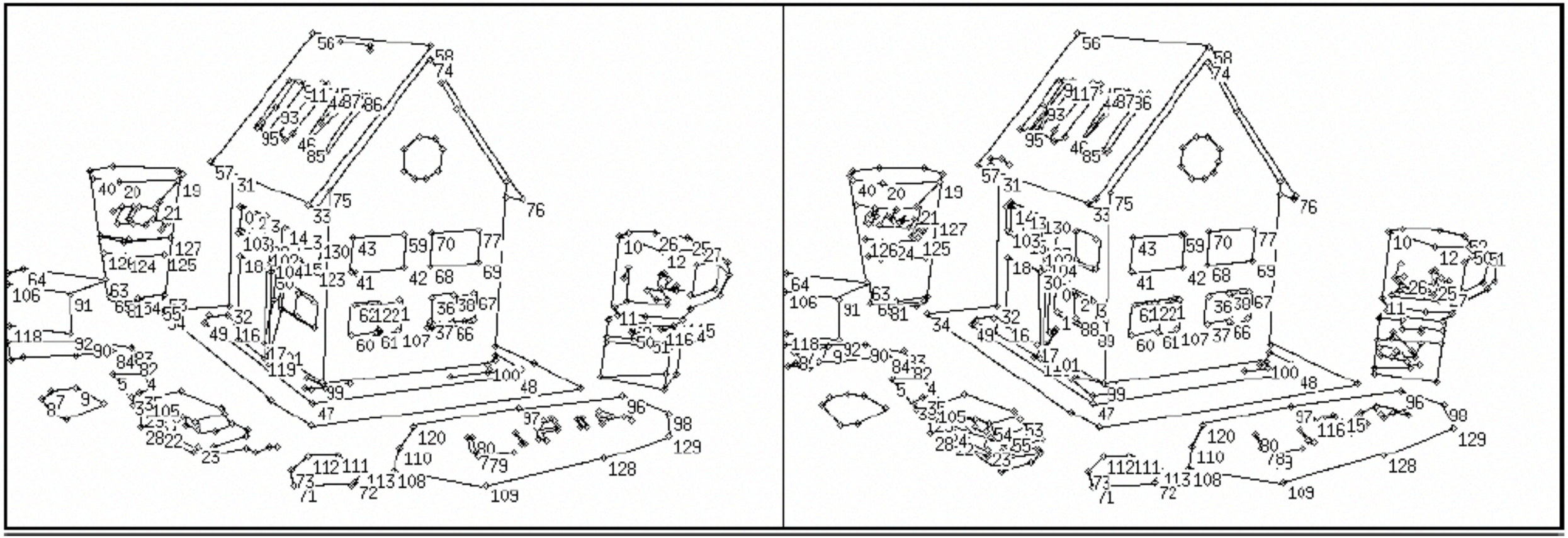
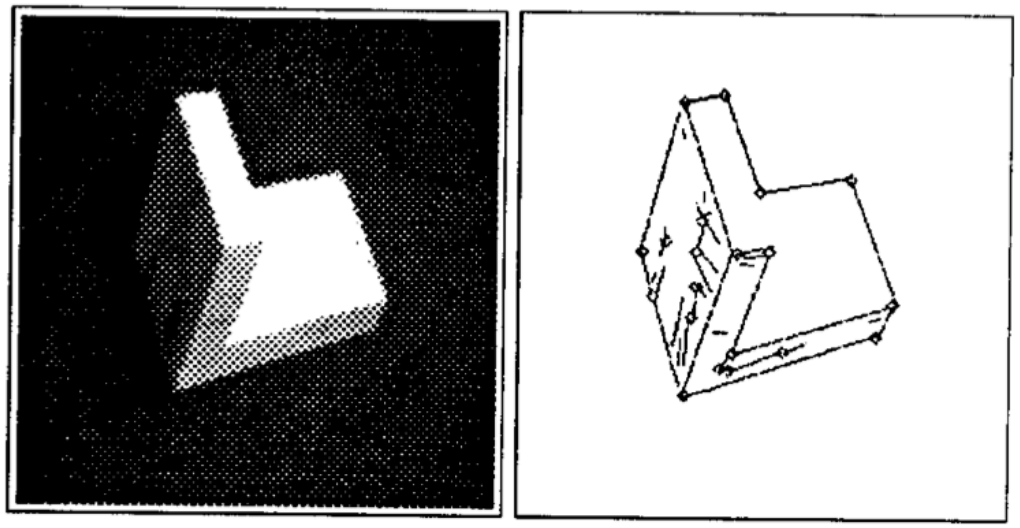
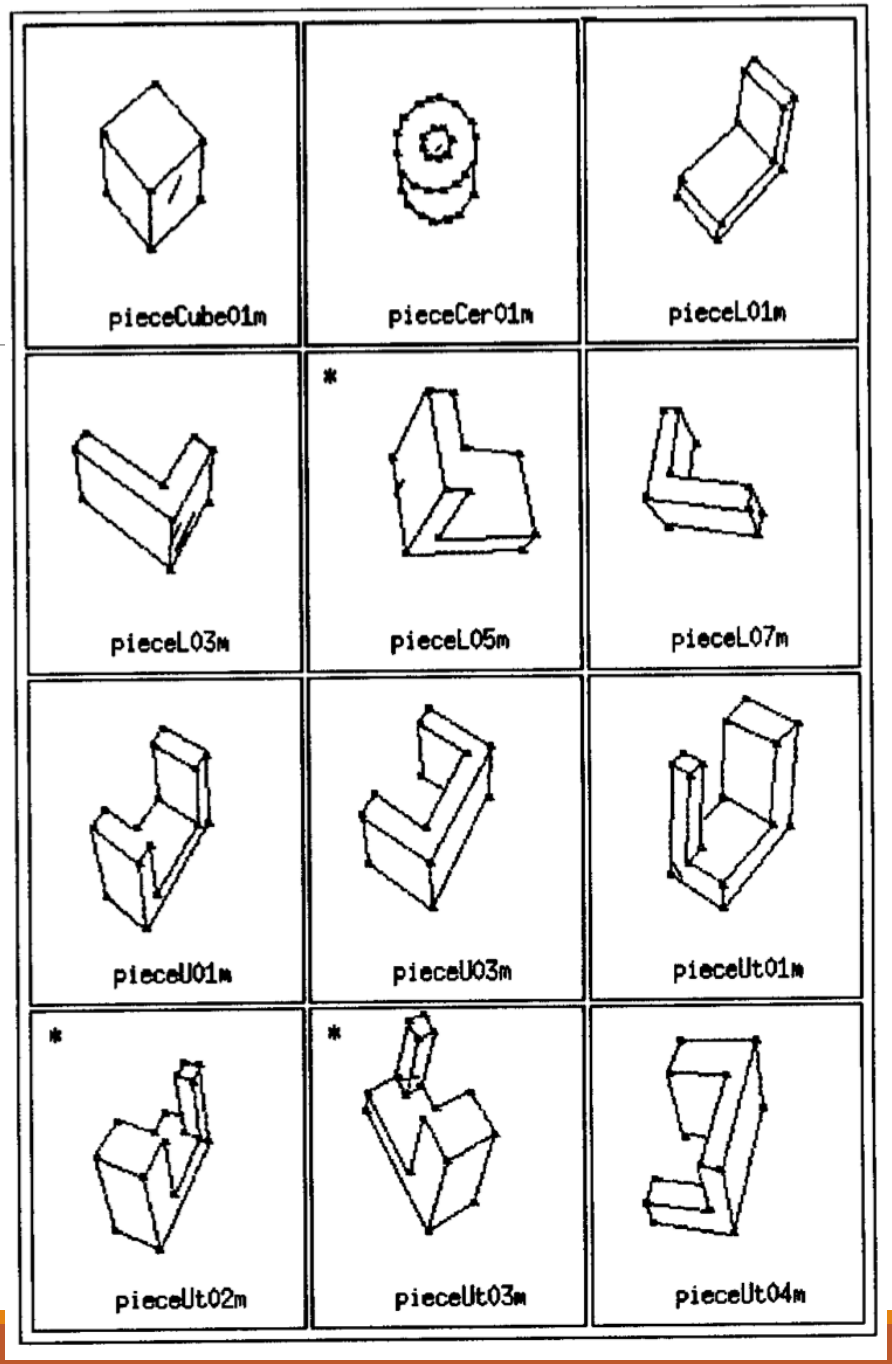


Image Matching



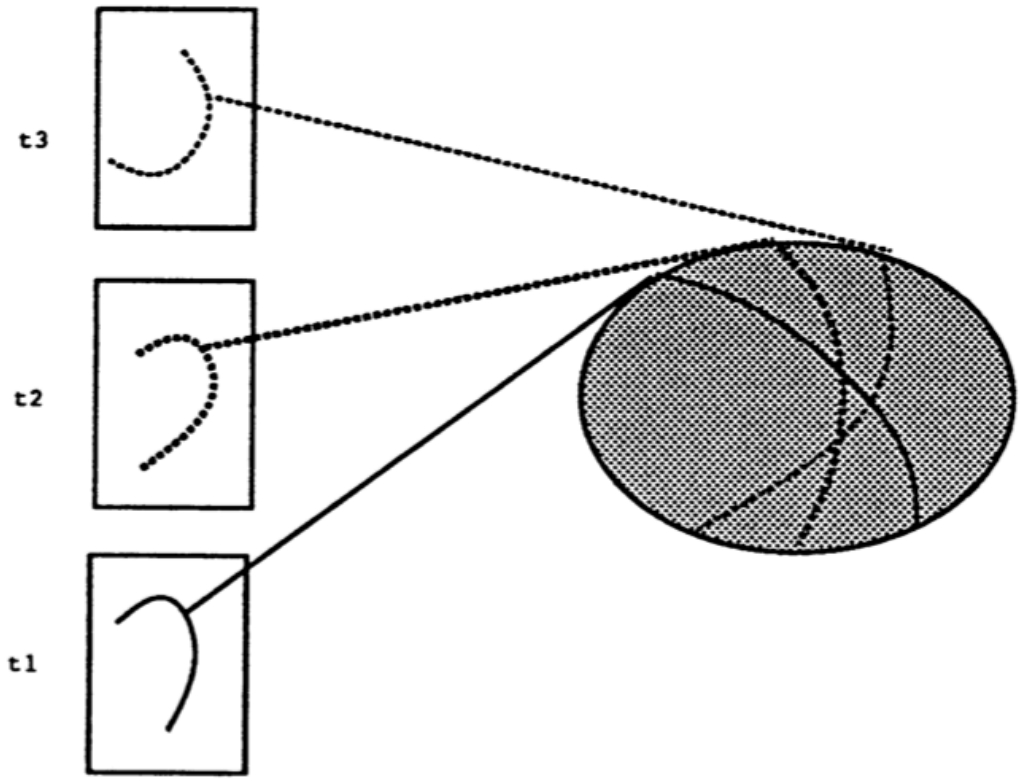
Object Recognition





- Topological descriptors of small graphs of segments -> Thesis of Humberto Sossa
- Numerical descriptors of very small graphs -> Thesis of Patrick Gros

Curved Object Reconstruction



Thesis of Emmanuel Arbogast

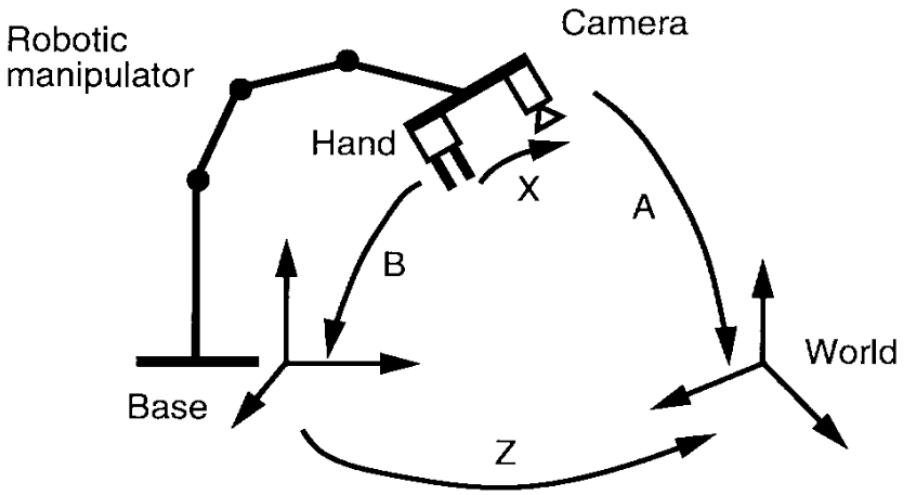
Thesis of Chang-Sheng Zhao

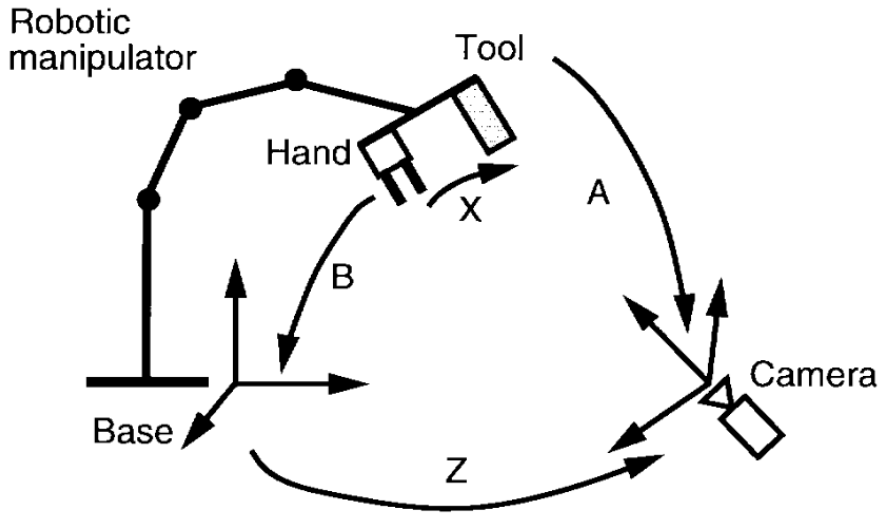
The Rise of Projective Geometry

- Camera calibration and self calibration

Thesis of Peter Sturm

- Hand-Eye calibration: calibrating the relation between and robot hand and a camera
  - The hand holds the camera
  - The camera looks at the hand



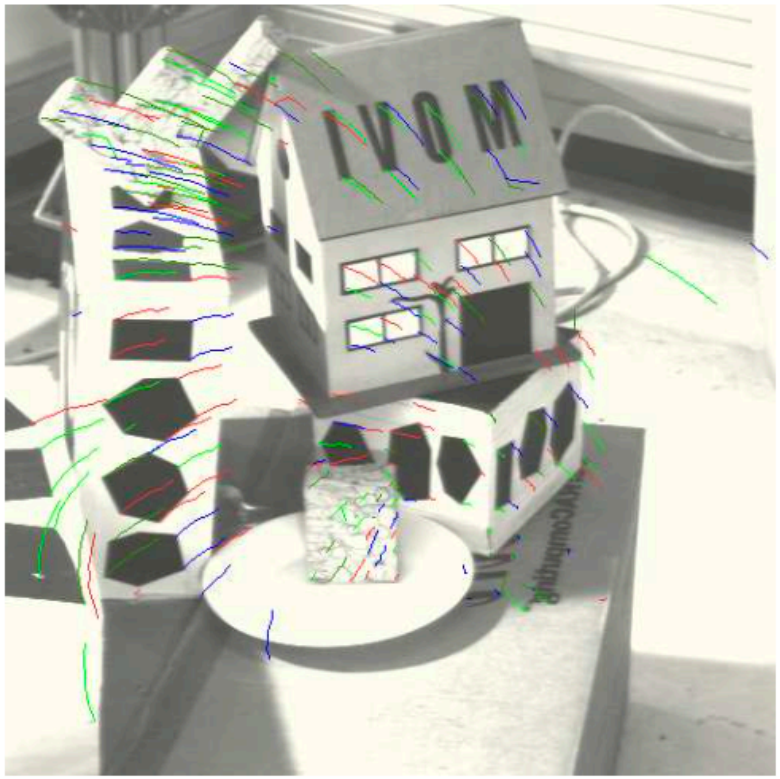


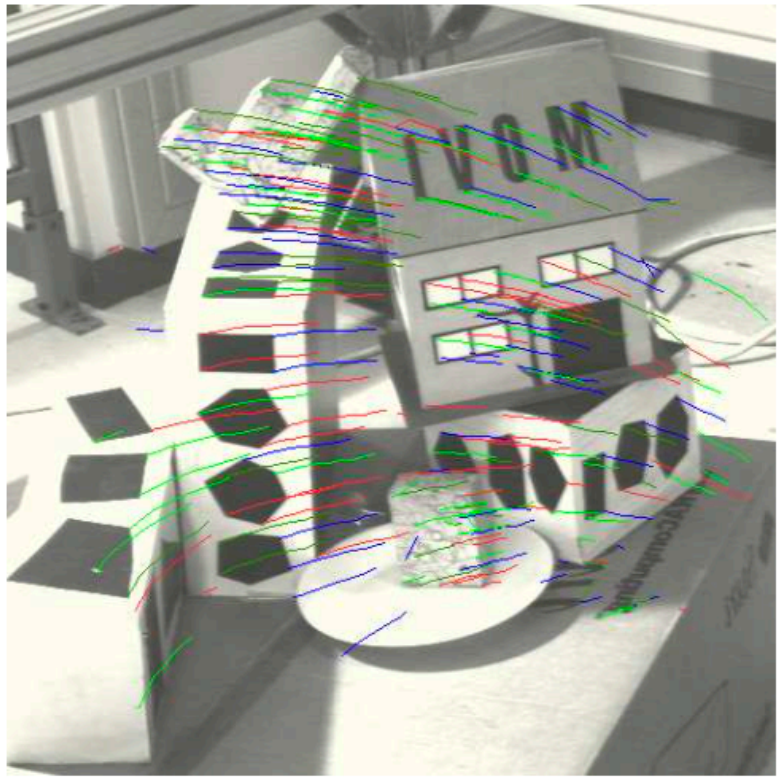
Thesis of Fadi Dornaika

Projective Motion

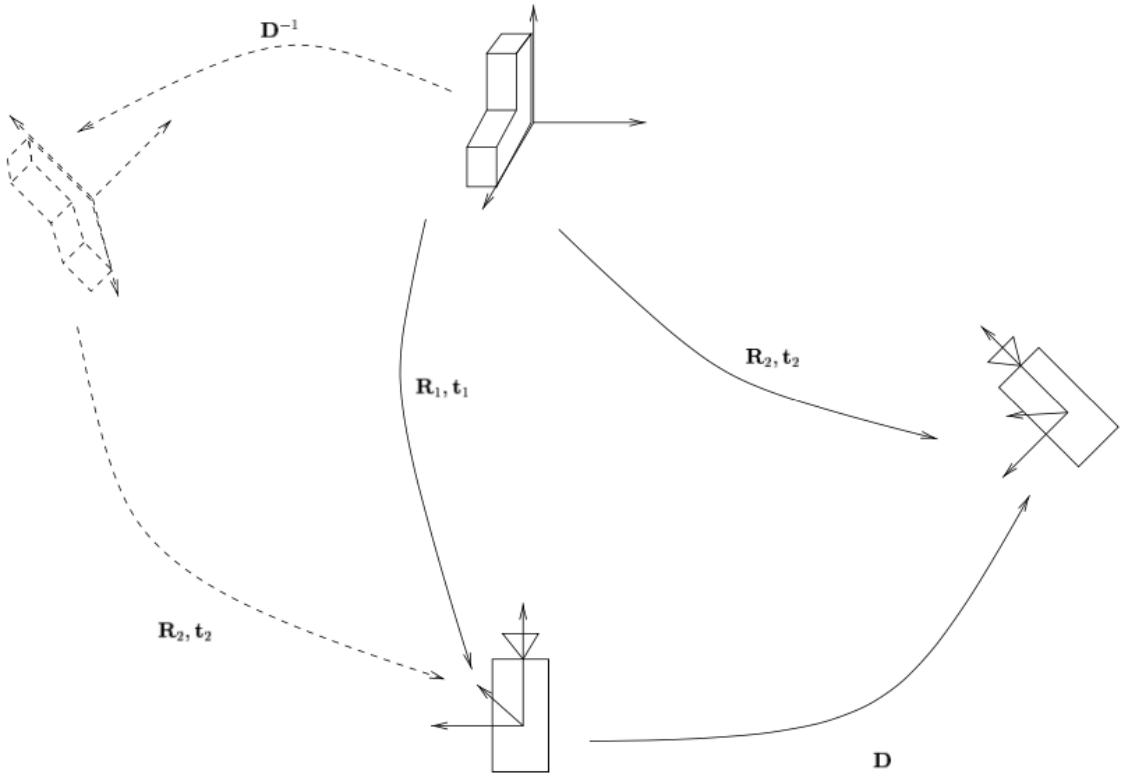
Self-calibration of a stereo rig

Thesis of David Demirdjian



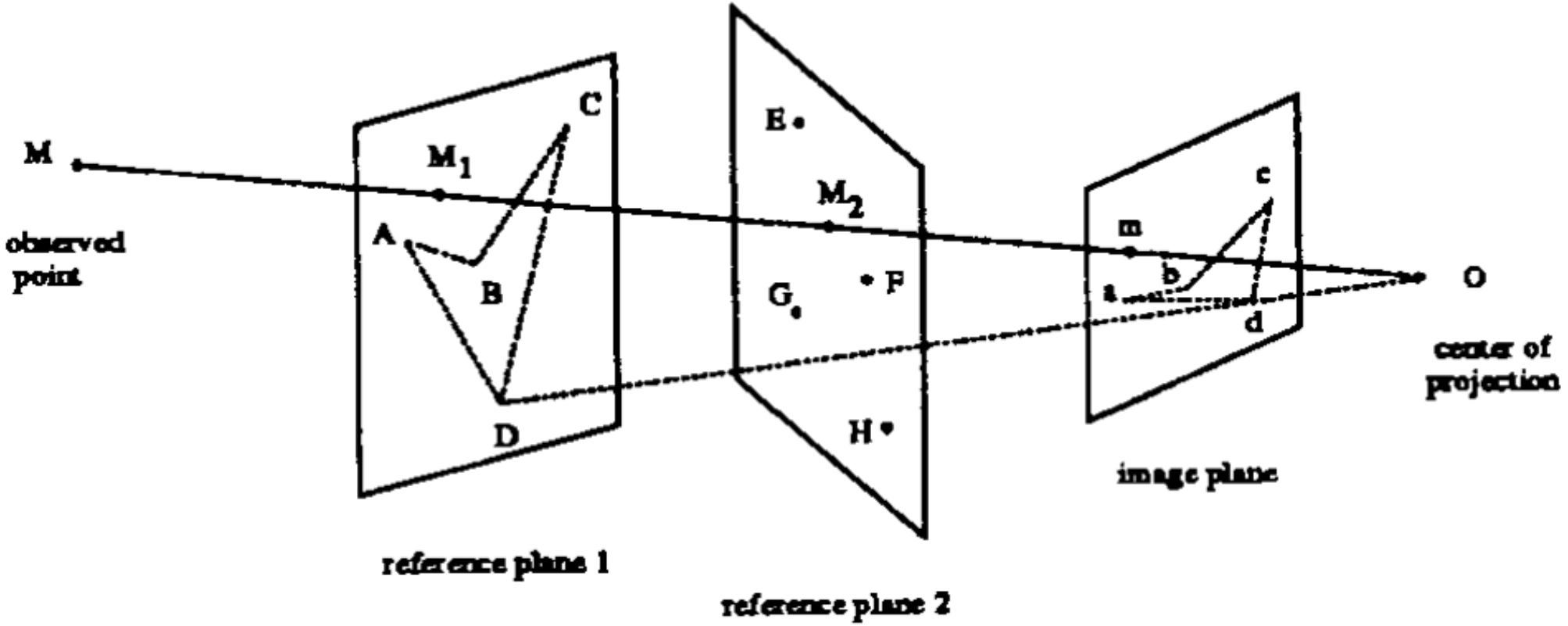


Visual Servoing and Self-Calibration



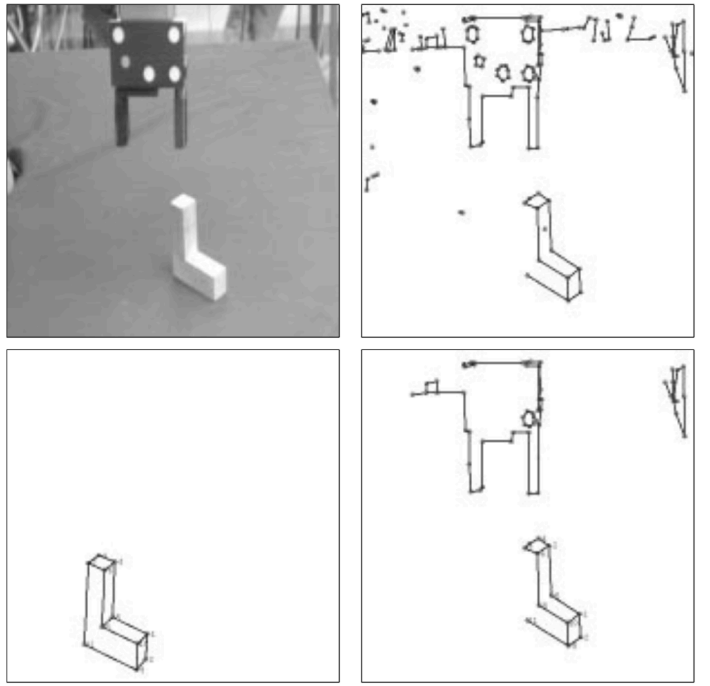
Thesis of Nicolas Andreff

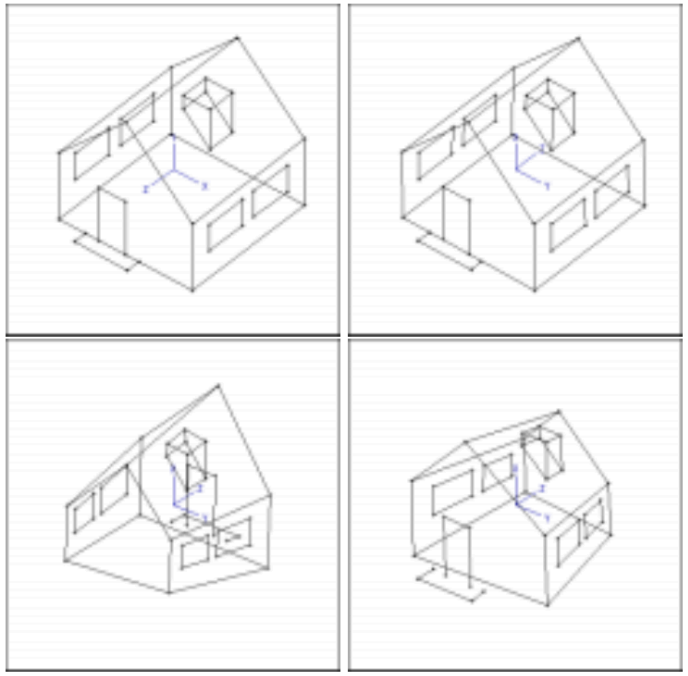
Positioning from Invariants

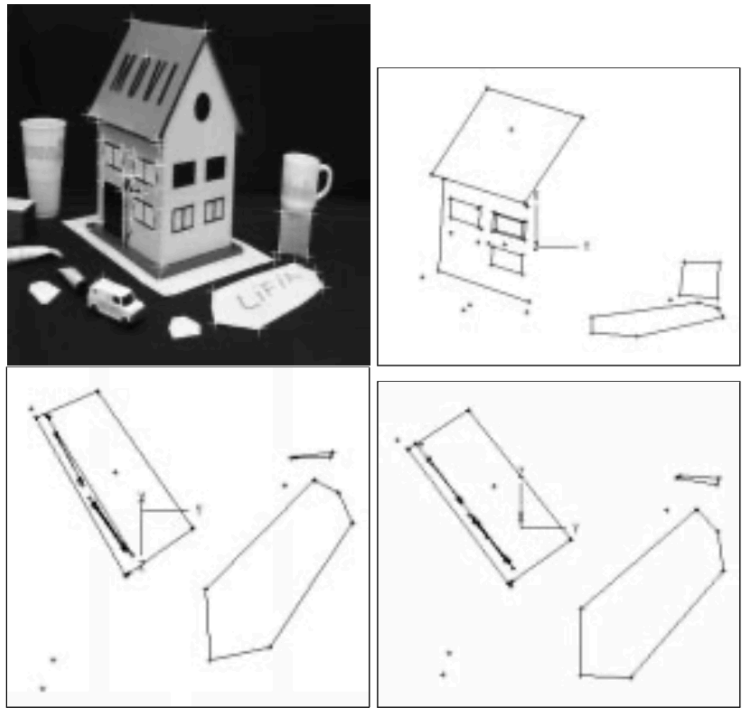


Thesis of Luce Morin

Approximating the Camera Model for Localization and Reconstruction





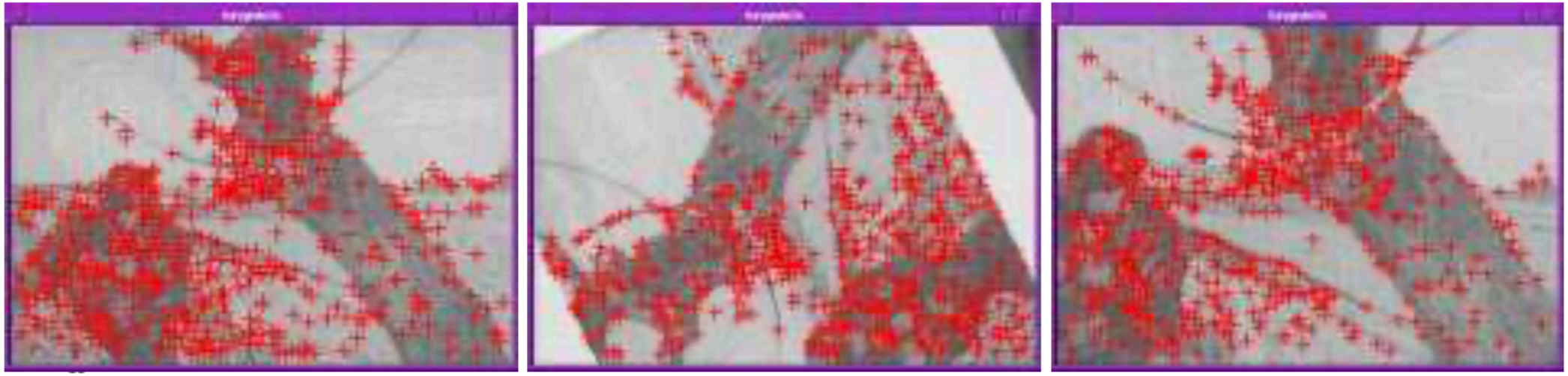


Thesis of Stéphane Christy

Towards New Paradigms

The use of grey levels!

Interest Points



+ Differential descriptors

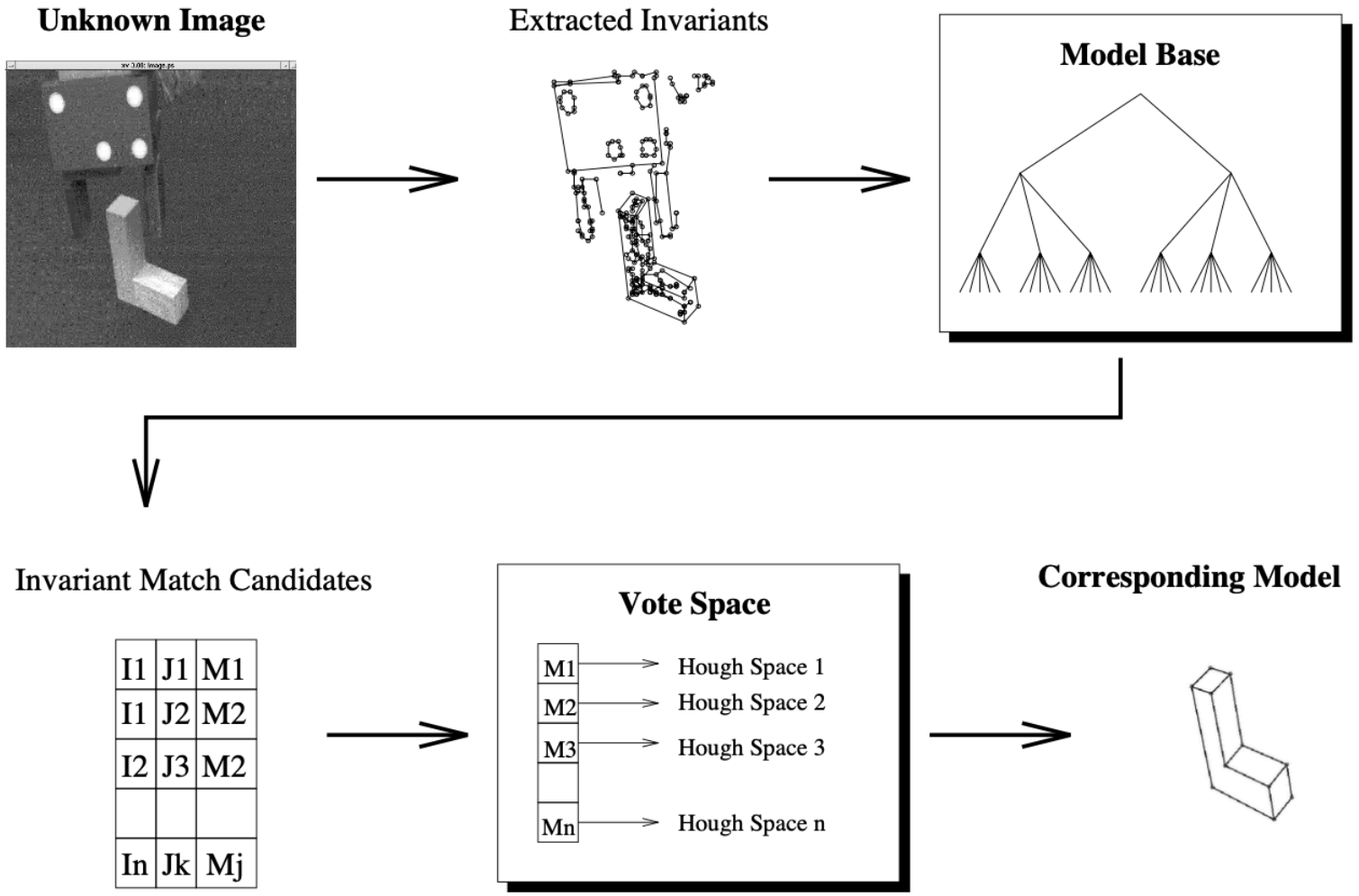
Thesis of Cordelia Schmid

$$\begin{bmatrix} L_{xxx}L_yL_yL_y + 3L_{xyy}L_xL_xL_y - 3L_{xxy}L_xL_yL_y - L_{yyy}L_xL_xL_x \\ L_{xxx}L_xL_yL_y + L_{xxy}(-2L_xL_xL_y + L_yL_yL_y) + L_{xyy}(-2L_xL_yL_y + L_xL_xL_x) + L_{yyy}L_xL_xL_y \\ L_{xxy}(-L_xL_xL_x + 2L_xL_yL_y) + L_{xyy}(-2L_xL_xL_y + L_yL_yL_y) - L_{yyy}L_xL_yL_y + L_{xxx}L_xL_xL_y \\ L_{xxx}L_xL_xL_x + 3L_{xxy}L_xL_xL_y + 3L_{xyy}L_xL_yL_y + L_{yyy}L_yL_yL_y \end{bmatrix}$$

Descriptors based on pixel comparisons

Thesis of Sylvaine Picard

Considering Large Databases



Thesis of Bart Lamiroy

And Neural Networks!

Champ moyen Cliques Coupures de graphes Groupement perceptif Informatique, automatique theorique, systemes Isomorphisme de graphes Optimisation combinatoire Recuit simule Reseaux de neurones Sciences

Thesis of Laurent Hérault

Résumé

Cette these traite de la resolution de problemes d'optimisation tres complexes (np. Complets) par le biais de l'etude des systemes complexes artificiels qui imitent les systemes physiques et qui sont simules avec des reseaux neuromimetiques. La solution optimale est identifiee a un etat fondamental d'un systeme physique. Plusieurs techniques neuronales sont presentees pour approcher la solution optimale. Elles utilisent soit l'analyse canonique, soit l'analyse microcanonique, definies en mecanique statistique. Parmi ces methodes, nous presentons l'utilisation des reseaux de hopfield analogiques, le recuit simule, l'approximation du champ moyen, le recuit en champ moyen et le recuit microcanonique. Elles sont particulierement bien adaptees aux problemes de graphes qui traitent de coupure et de connectivite, de morphisme et d'extraction de sous-graphes possedant des proprietes extremales. Dans ce cadre, les problemes de k-partitionnement de graphe, de mise en correspondance de graphes, et d'extraction de la plus grande clique sont traites. Dans la derniere partie, nous abordons le probleme de groupement perceptif en vision par ordinateur. On montre que ce probleme se ramene, par le biais de la theorie de la gestalt definie en psychologie experimentale, a un probleme d'optimisation combinatoire soluble par reseaux de neurones

And Neural Networks!

Defended in 1991!!!

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About Radu

About Radu

- He was my boss, I was his boss (one of the two in this case)
- Not far from the mainstream of computer vision, but always with original ideas (projective motion, projective approximations… ad now audio-visual scenes)
- Always kept a link with robotics : grasping, localization and now robot-human interfaces
- Always kept a link with applications and industrial companies
- Always involved in large projects and espacially large European projects

- And was advisor for a lot of persons!

Marta Wilczkowiak, Stéphane Christy, Andreas Ruf, Clément Ménier, Fadi Dornaika, David Demirdjian, Adrien Bartoli, Christophe Icord, Andrei Zaharescu, Laurent Hérault, Thomas Skordas, Jordi Sanchez-Riera, Yves Dufournaud, Diana Caroline Mateus Lamus, Humberto Sossa, Stéphane Lathuilière, Antoine Deleforge, Avinash Sharma, Benoît Massé, Vincent Drouard, Israël Dejene Gebru, Yves Dufournaud, David Knossow, Thomas Bonfort, Nicolas Andreff, Jean-Sébastien Franco, Bart Lamiroy, Xavier Alameda-Pineda, Dionysos Kounadis-Bastian, Ramya Narasimha, Guillaume Delorme, Ouided Bentrah, Aude Jacquot, Guillaume Dewaele, Daniel Weinland, Yihong Xu, Yutong Ban…

Many thanks!