



PASCAL INSTITUTE

CLERMONT-FERRAND, FRANCE



STRUCTURATION



INSTITUT
PASCAL
sciences de l'ingénierie et des systèmes

Teams

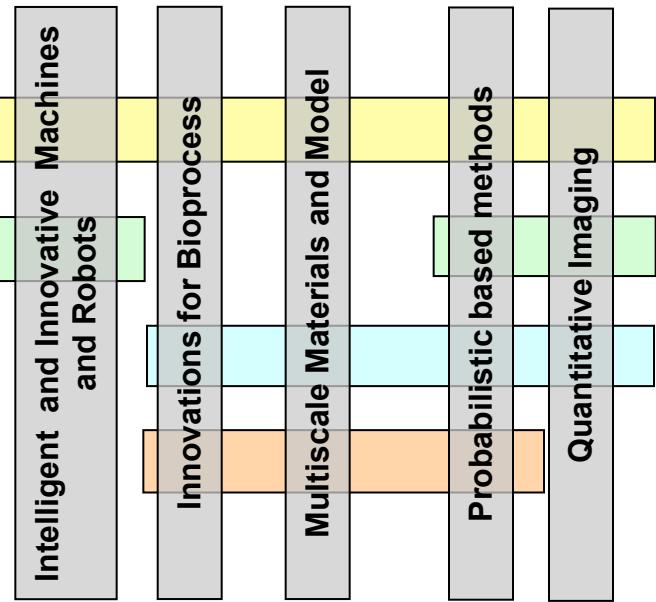
Mechanical, Materials and Structures

Computer vISion, Perception systems and Robotics

Process Engineering, Energetics and Biosystems

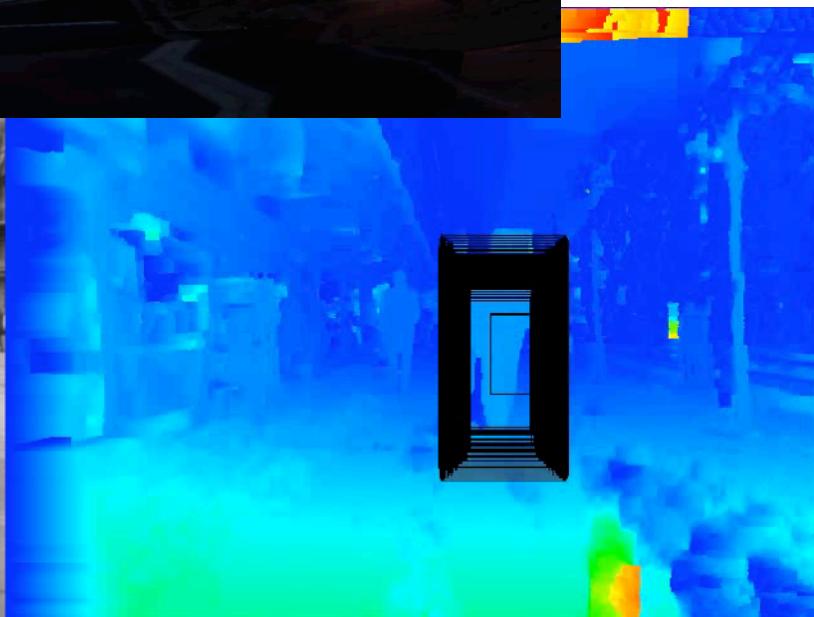
Photonics, Microwave, Nanomaterials

Disciplinary topics



COMPUTERS THAT SEE

2012



CONTENT

- Relevant keywords about ISPR/ComSee
- **Topic 1** : Threedimensional Reconstruction of Rigid Scenes and Vision-Based Metrology
- **Topic 2** : Visual Identification and Tracking

ISPR/COMSEE: RELEVANT KEYWORDS

- **ComSee members (Nov. 2012): (39)**
 - Permanent members: 9 researchers
 - Non permanent members: 19 Phd, 3 PostDoc, 3 Engineers
 - 5 associate professors
- **Publications (2007-2010):**
 - 20 International journals articles (IJCV, Pattern recognition, PAMI, ...)
 - 96 articles in International Conferences (CVPR, ICCV, ECCV, ...)
- **Patents, 2007-2010 (Systems and softwares): 5**
- **Current funded projects: 6**

ISPR/COMSEE: RELEVANT KEYWORDS

- **Starred Current funded projects:**

- **BIORAFALE**: OSEO-funded 3 years (2009-2012) project on visual recognition and identification of football Hooligans, partner's funding, 202K€;
- **Ispace&Time**: ANR-funded 3 years (2011-2014) project on the next generation urban 4D SIG, Partner's funding, 150K€;
- **3DSTRAIN**: ANR-funded 4 years (2011-2015) Heart Medical Imaging, Partner's funding, 175 K€;

ISPR/COMSEE: RELEVANT KEYWORDS

- Starred industrial partners:

- Michelin;



- Teb;



- Renault;



- IGN;



- Thales;



- CEA.



- Starred local industrial partners:

- Vesalis, Effidence, APRV, Exotic Systems, Apojee, Ligier,



ISPR/COMSEE: RELEVANT KEYWORDS

- Starred research and academic partners:

- INRIAs;



- Ecole polytechnique Montréal;



- Camberra University;



- SKKU, Korea ;



- GipsaLab



- IGN;

- CEA.

- Starred local research and academic partners:

- Irstea, Limos, ISIT, LMA.

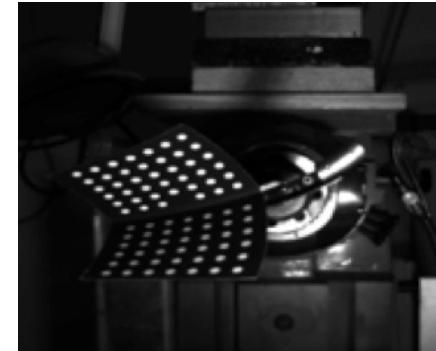


CONTENT

- Relevant keywords about ISPR/ComSee
- **Topic 1 : Threedimensional Reconstruction of Rigid Scenes and Vision-Based Metrology**
- Topic 2 : Visual Identification and Tracking

Three-dimensional Reconstruction of Rigid Scenes and Vision-Based Metrology

- Vision based metrology of dynamic scenes using a rolling-shutter camera.
- 3D Reconstruction of complex rigid scenes
- 3D Localisation by monocular camera



THREEDIMENSIONAL RECONSTRUCTION OF RIGID SCENES AND VISION-BASED METROLOGY

Members (permanent)

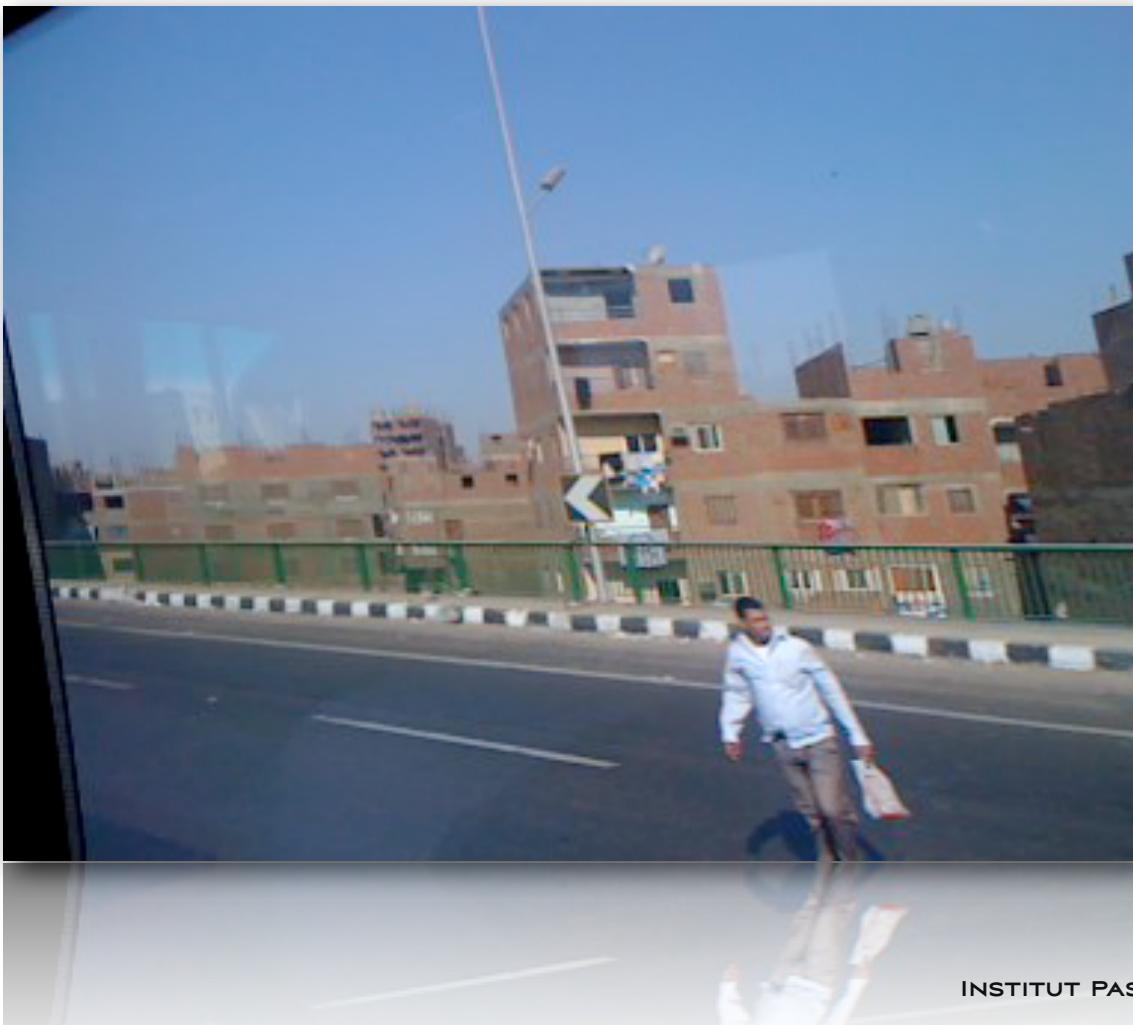
- M. Lhuillier, (2 PhDs (co)-supervision)
- M. Dhome, (3 PhDs (co)-supervision)
- J.M. Lavest, (2 PhDs (co)-supervision)
- O. Ait-Aider, (4 PhDs (co)-supervision)
- E. Royer, (2 PhD (co)-supervision)

THREEDIMENSIONAL RECONSTRUCTION OF RIGID SCENES AND VISION-BASED METROLOGY

Roadmap

- **High speed rolling shutter Sensors**
 - 3D reconstruction algorithms for rolling shutter cameras
- **3D reconstruction of rigid scenes**
 - surface estimation based on structure from motion
 - heterogeneous models for 3D models
- **Localisation**
 - robust matching algorithms
 - Visual models using GIS and sensor fusion

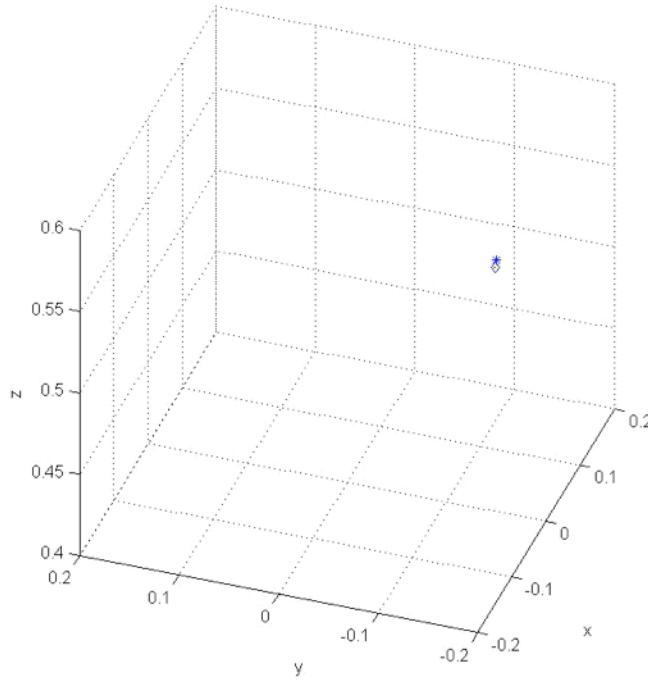
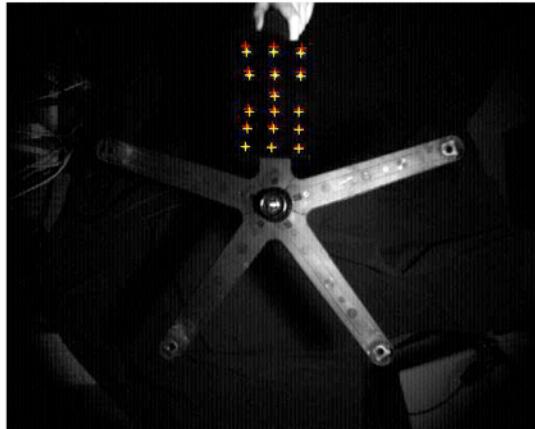
Vision based metrology of dynamic scenes using a rolling-shutter camera.



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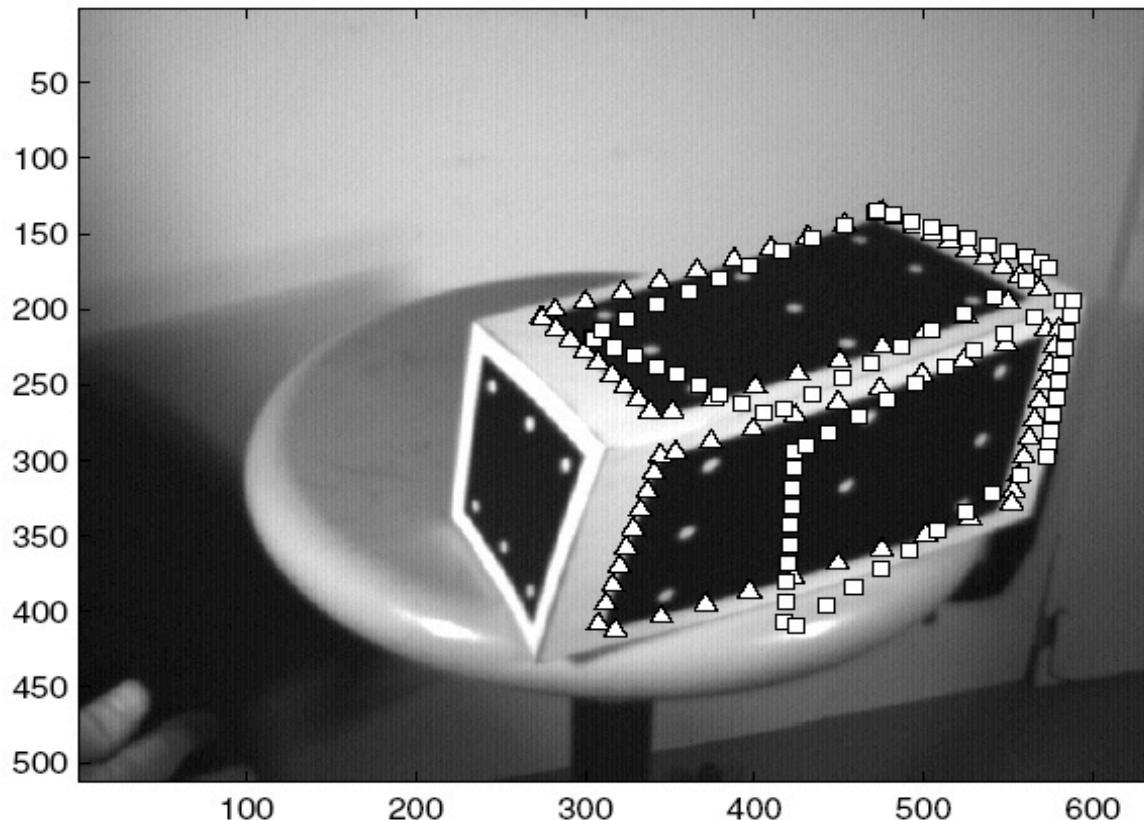
Vision based metrology of dynamic scenes using a rolling-shutter camera.

- rolling shutter model for constant velocity (award, ECCV'06)



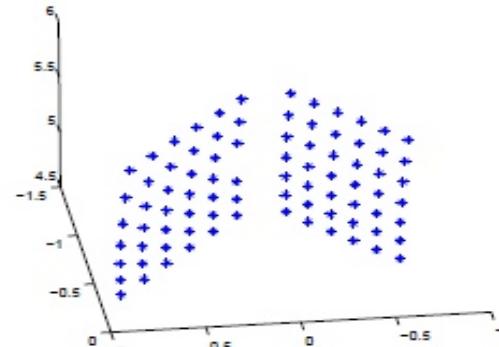
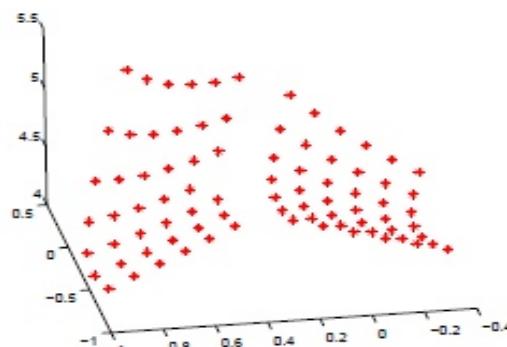
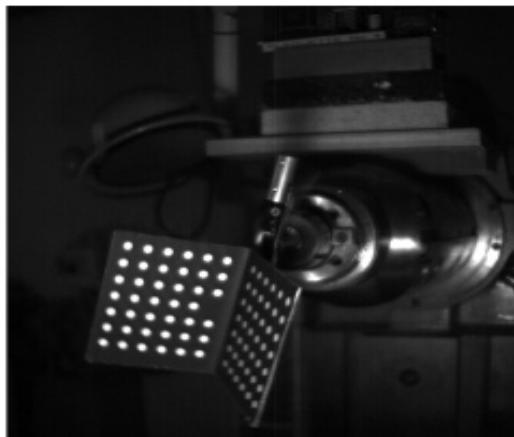
Vision based metrology of dynamic scenes using a rolling-shutter camera.

- pose and motion estimation from one image using straight lines matching (CVPR'07)



Vision based metrology of dynamic scenes using a rolling-shutter camera.

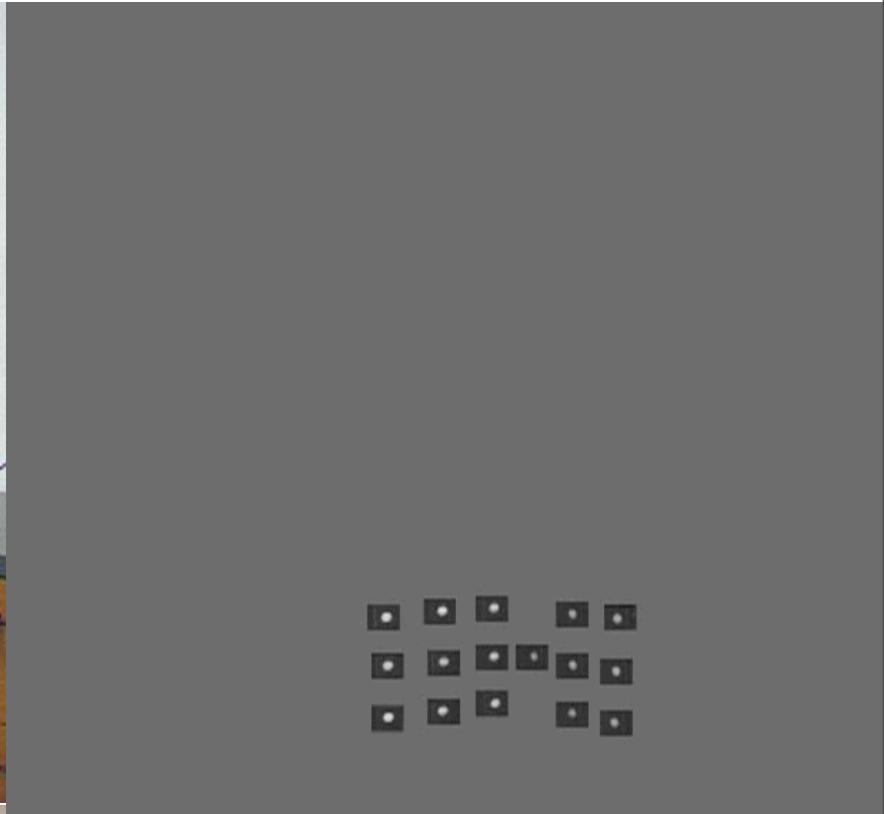
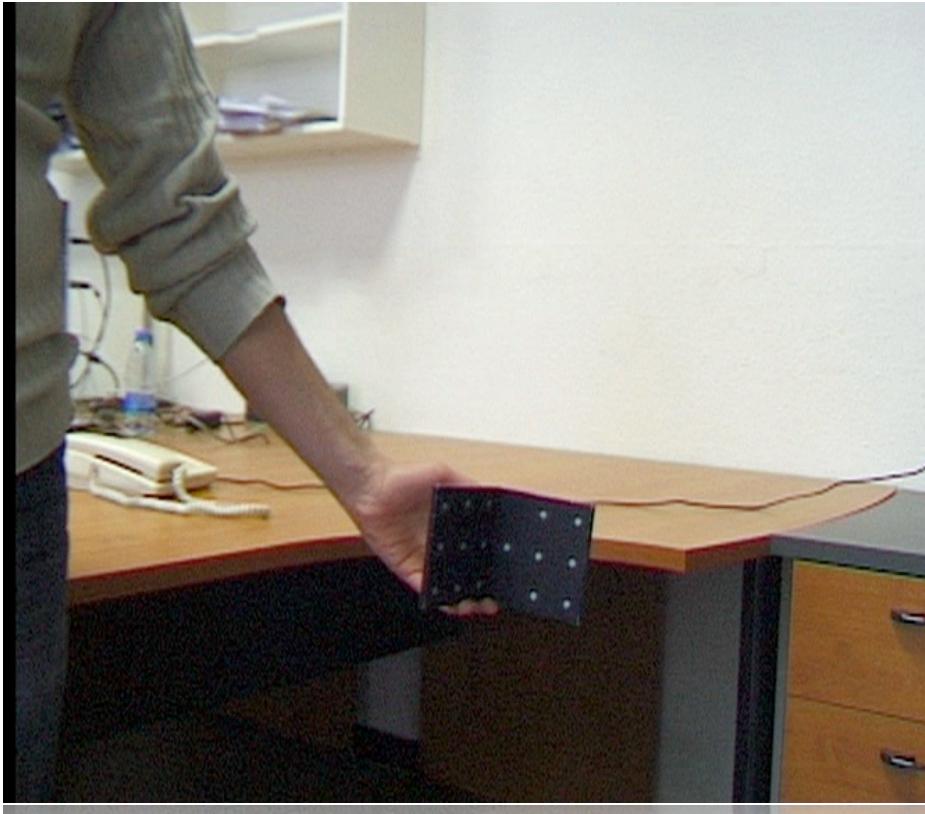
- spatio-temporal triangulation (structure and motion) for rolling-shutter cameras (ICCV'09)



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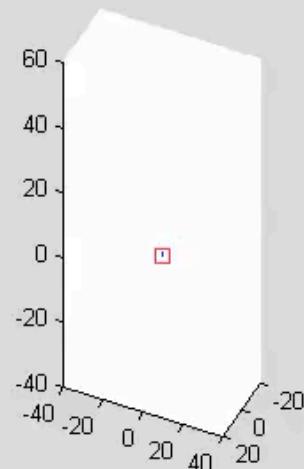
Vision based metrology of dynamic scenes using a CMOS camera.

- Structure and motion estimation using dynamic ROIs into a CMOS camera (ICRA'08), (high speed tracking, 2000fps)



ISPR/COMSEE: 3D RECONSTRUCTION

3D-Reconstruction with exotic sensors (SeeMove project)



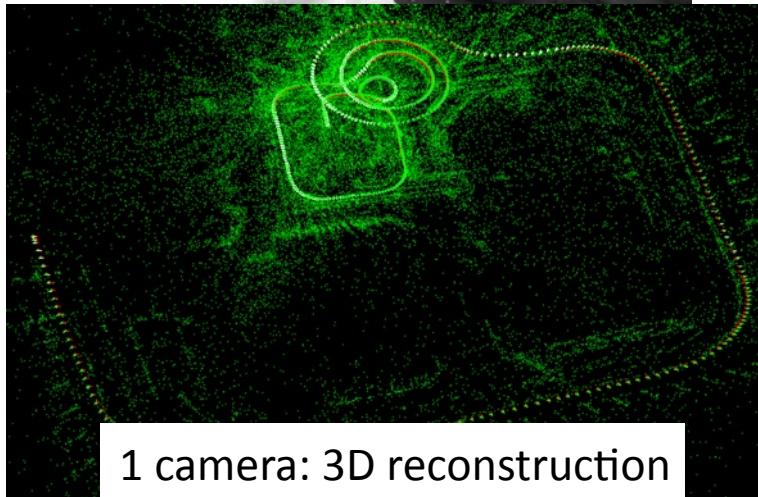
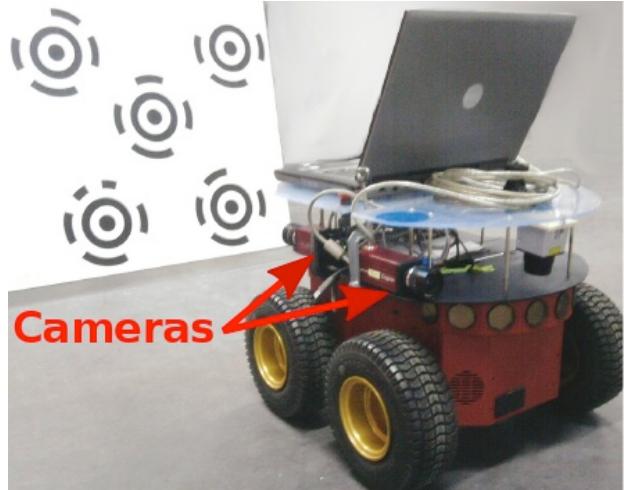
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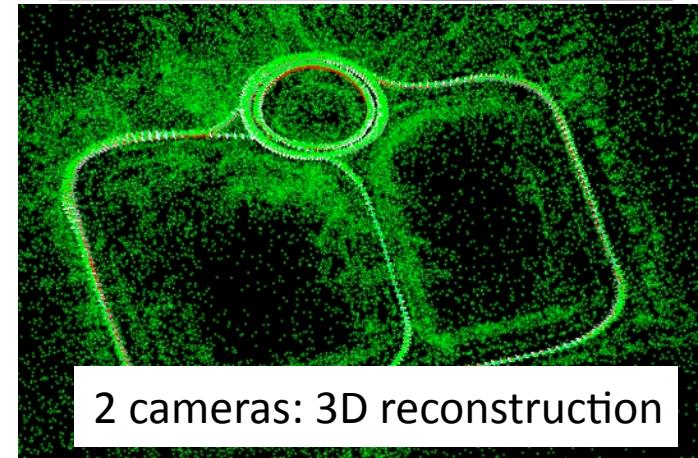
3D-Reconstruction of complex rigid scenes

And non-overlapping camera calibration

- Goal: estimate rotation and translation between the cameras



Pierre Lébraly (PhD)



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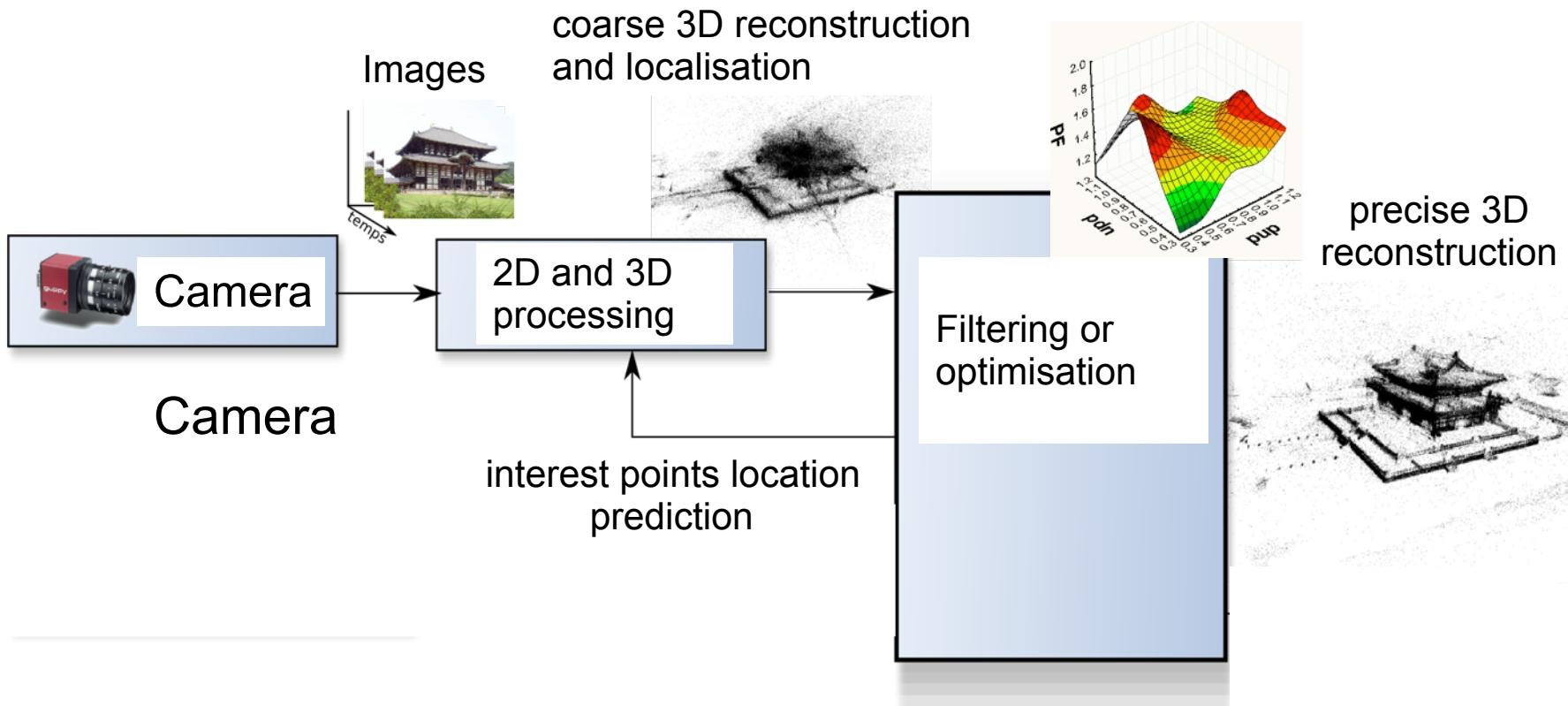
Three-dimensional Reconstruction of Rigid Scenes and Vision-Based Metrology

- Vision based metrology of dynamic scenes using a rolling-shutter camera.
- **3D Reconstruction of complex rigid scenes**
- 3D Localisation by monocular camera



3D-Reconstruction of complex rigid scenes

Based on Structure from motion techniques



3D-Reconstruction of complex rigid scenes

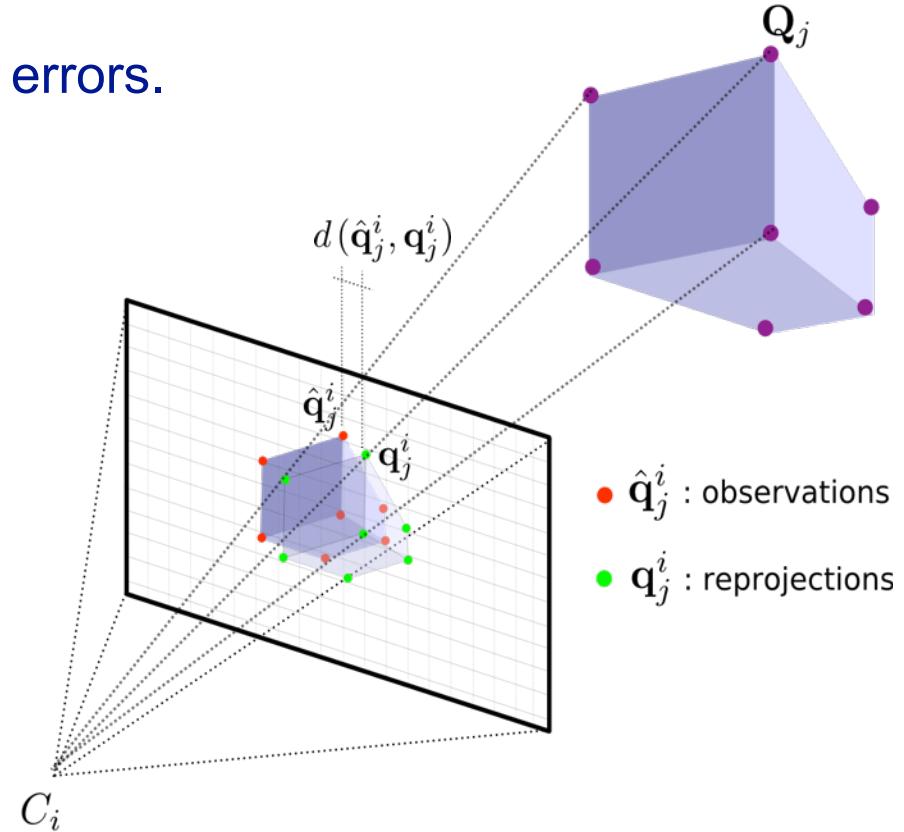
Based on Structure from motion techniques

- Goal: minimize the reprojection errors.

$$\mathbf{x}^* = \arg \min_{\mathbf{x} \in \mathfrak{M}} F^c(\mathbf{x}) = \sum_{i=1}^{N_m} \sum_{j=1}^{N_n} \nu_j^i d(\hat{\mathbf{q}}_j^i, \mathbf{q}_j^i)^2$$

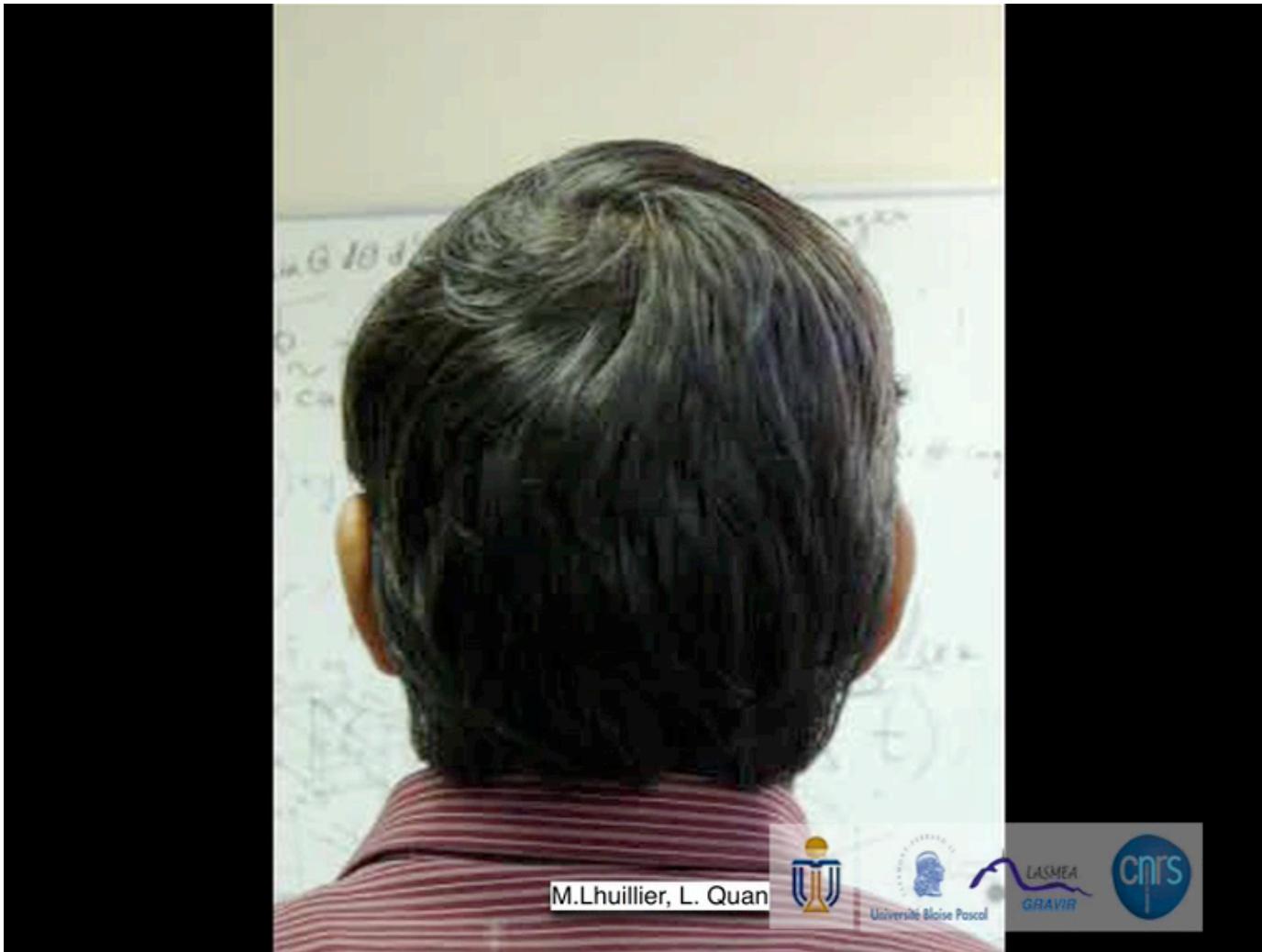
$$d(\hat{\mathbf{q}}_j^i, \mathbf{q}_j^i) = \|\hat{\mathbf{q}}_j^i - \Psi(\mathcal{P}_i \mathbf{Q}_j)\|_2$$

● obs.
 ● reprojection



ISPR/COMSEE: 3D RECONSTRUCTION

3D-Reconstruction of complex rigid scenes (classic camera)



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ISPR/COMSEE: 3D RECONSTRUCTION

3D-Reconstruction of complex rigid scenes (catadioptric camera)

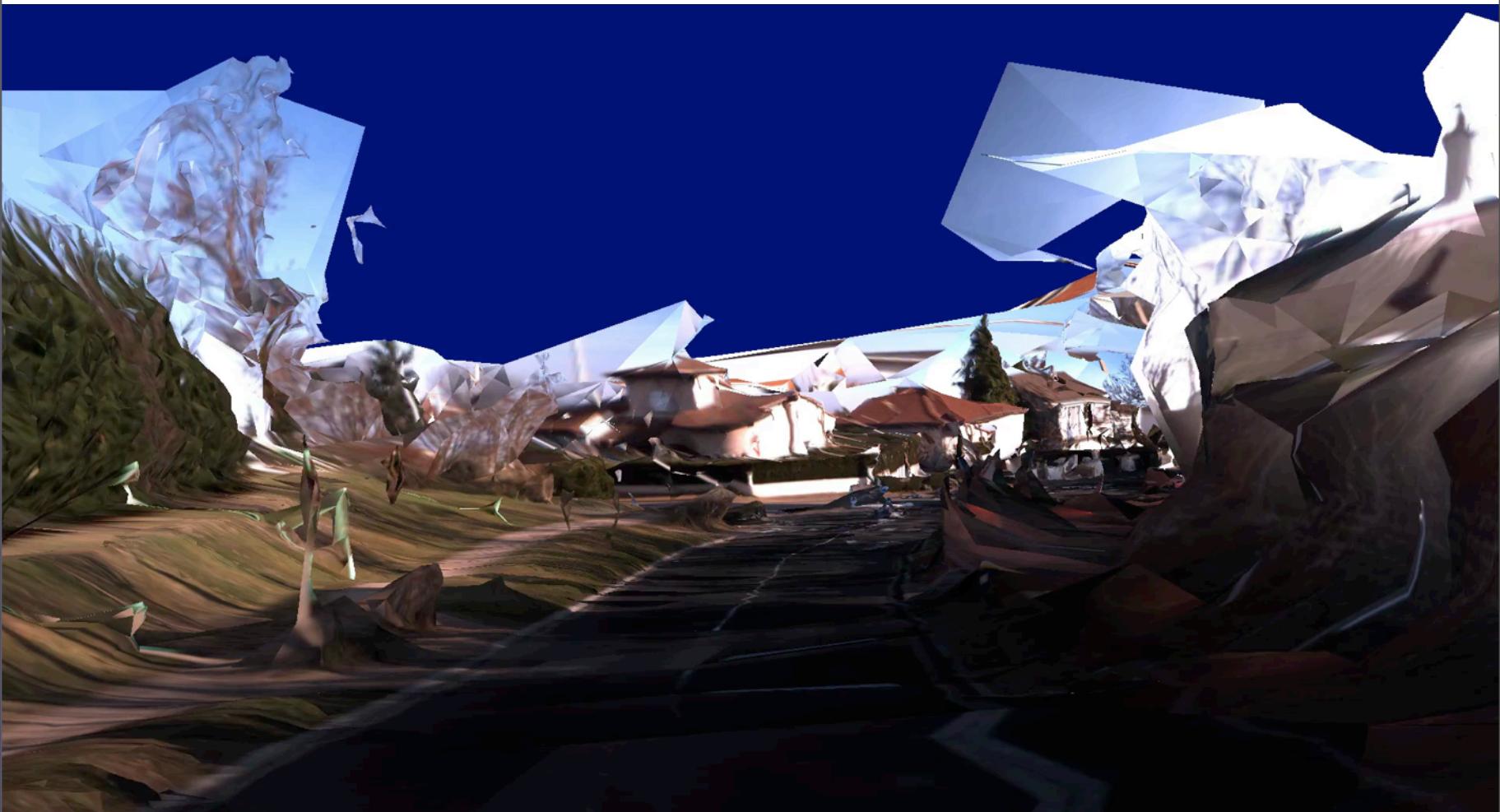


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ISPR/COMSEE: 3D RECONSTRUCTION

3D-Reconstruction of complex rigid scenes (Labybug)

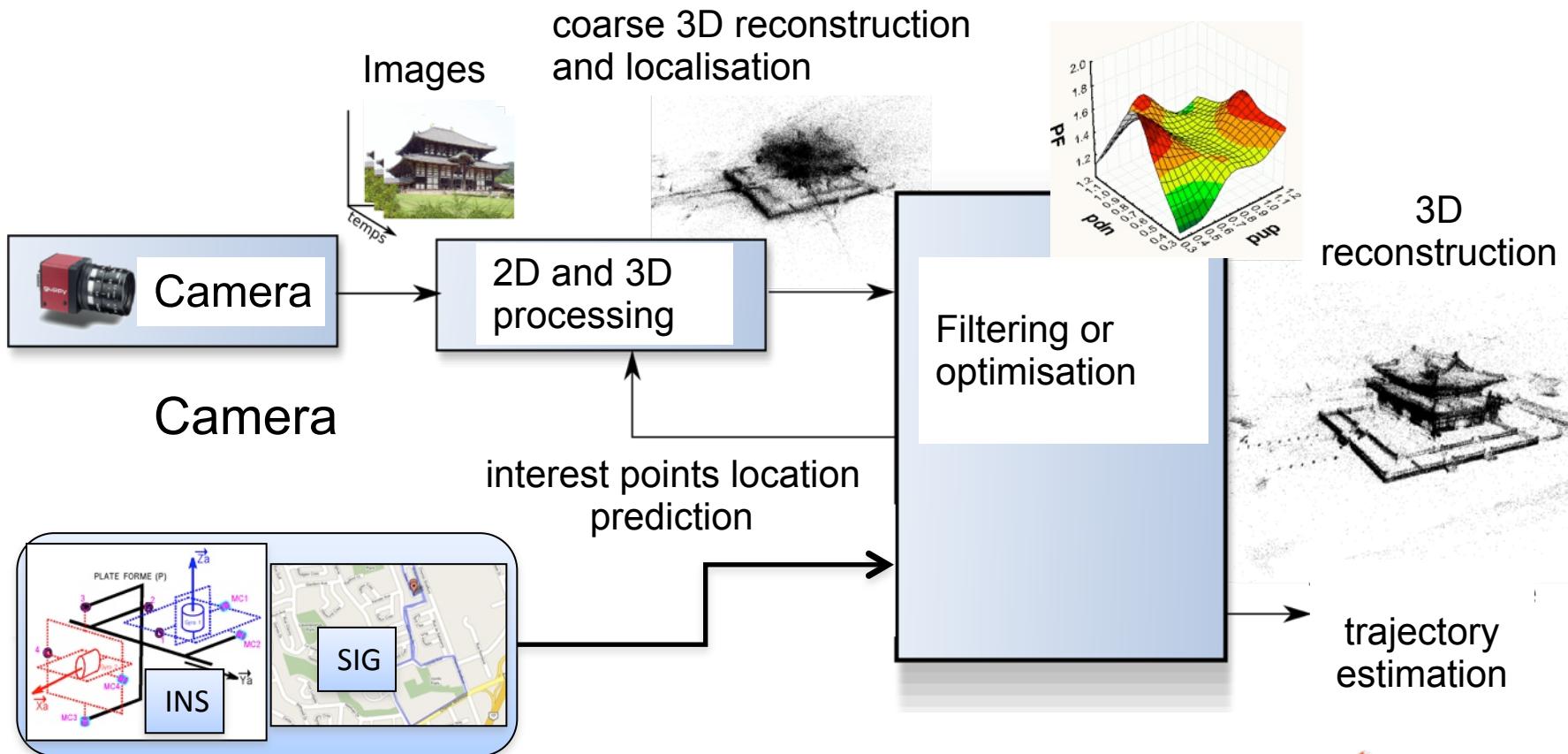


Three-dimensional Reconstruction of Rigid Scenes and Vision-Based Metrology

- Vision based metrology of dynamic scenes using a rolling-shutter camera.
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Based on Structure from motion techniques

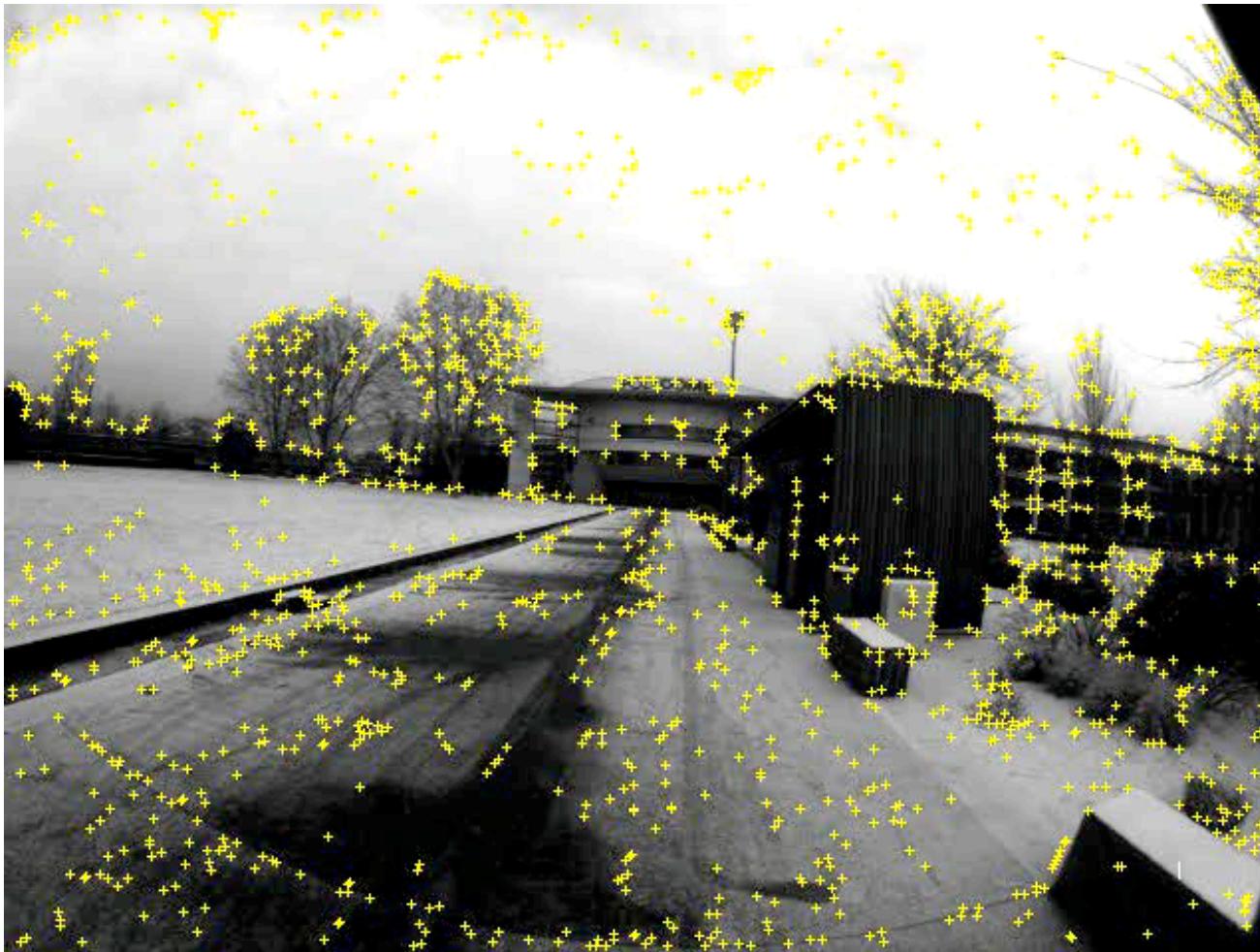


Monocular based localisation for automatic guidance

Step 1: supervised guidance and video recording

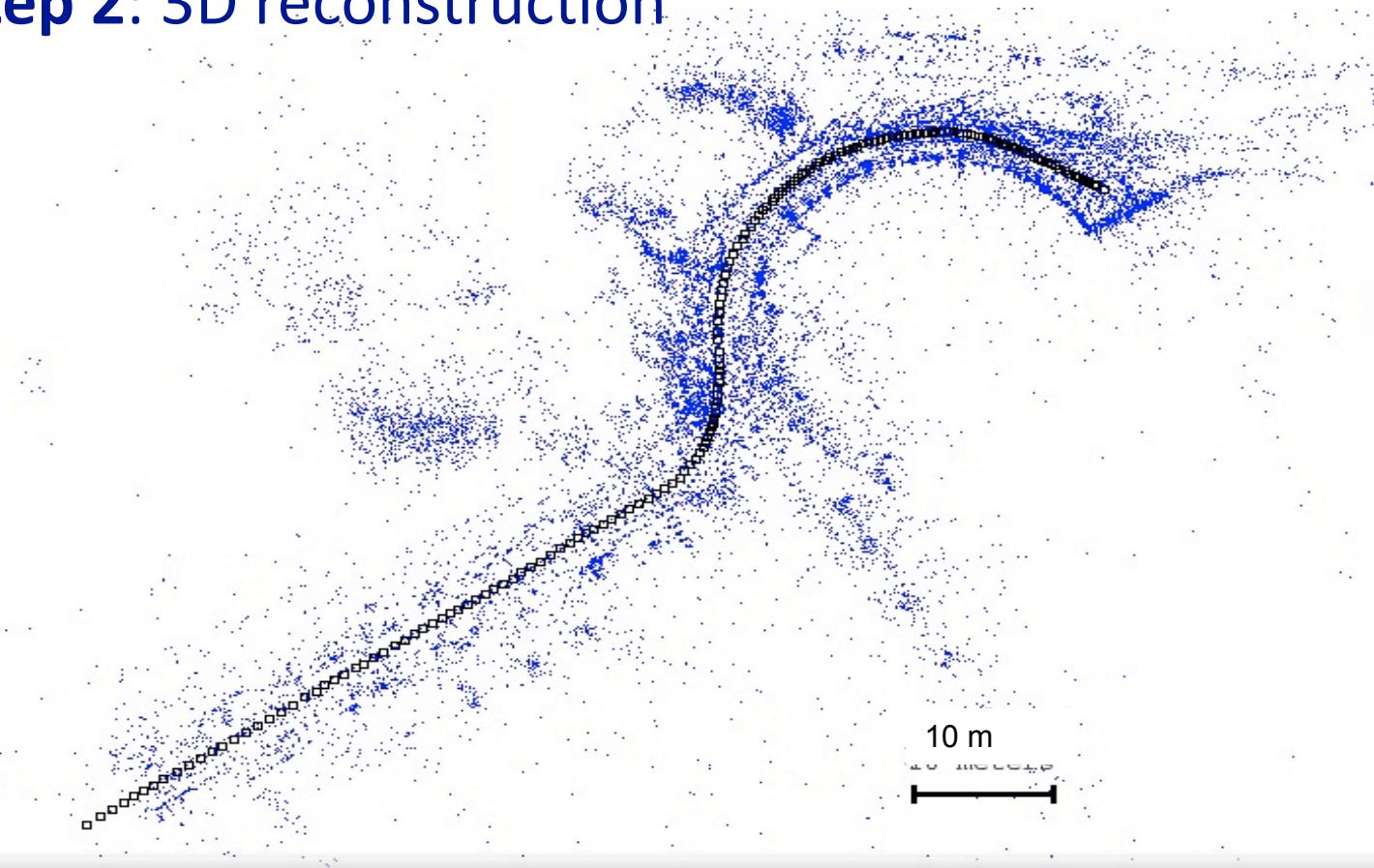


Step 2: 3D reconstruction



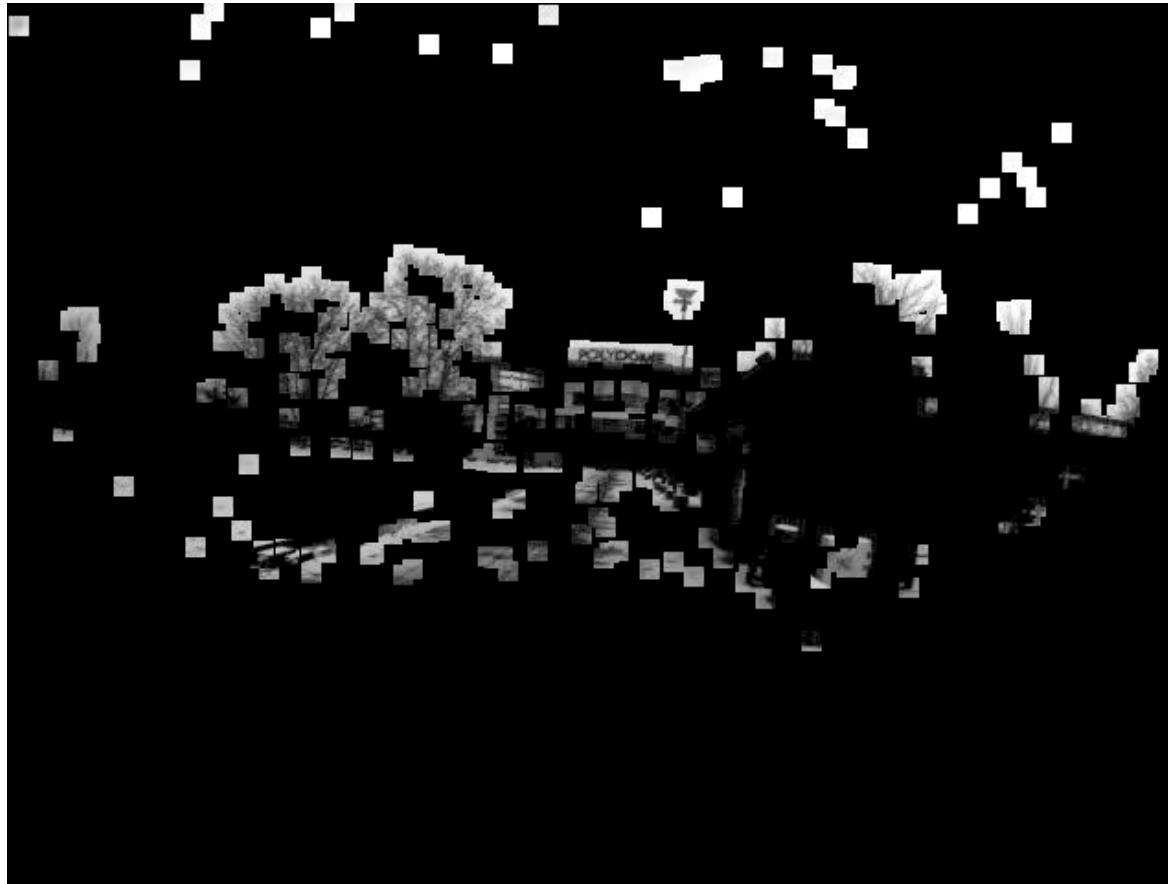
Interest point detection

Step 2: 3D reconstruction



**3D reconstructed points
(125 m, 172 key images, 23000 3D image)**

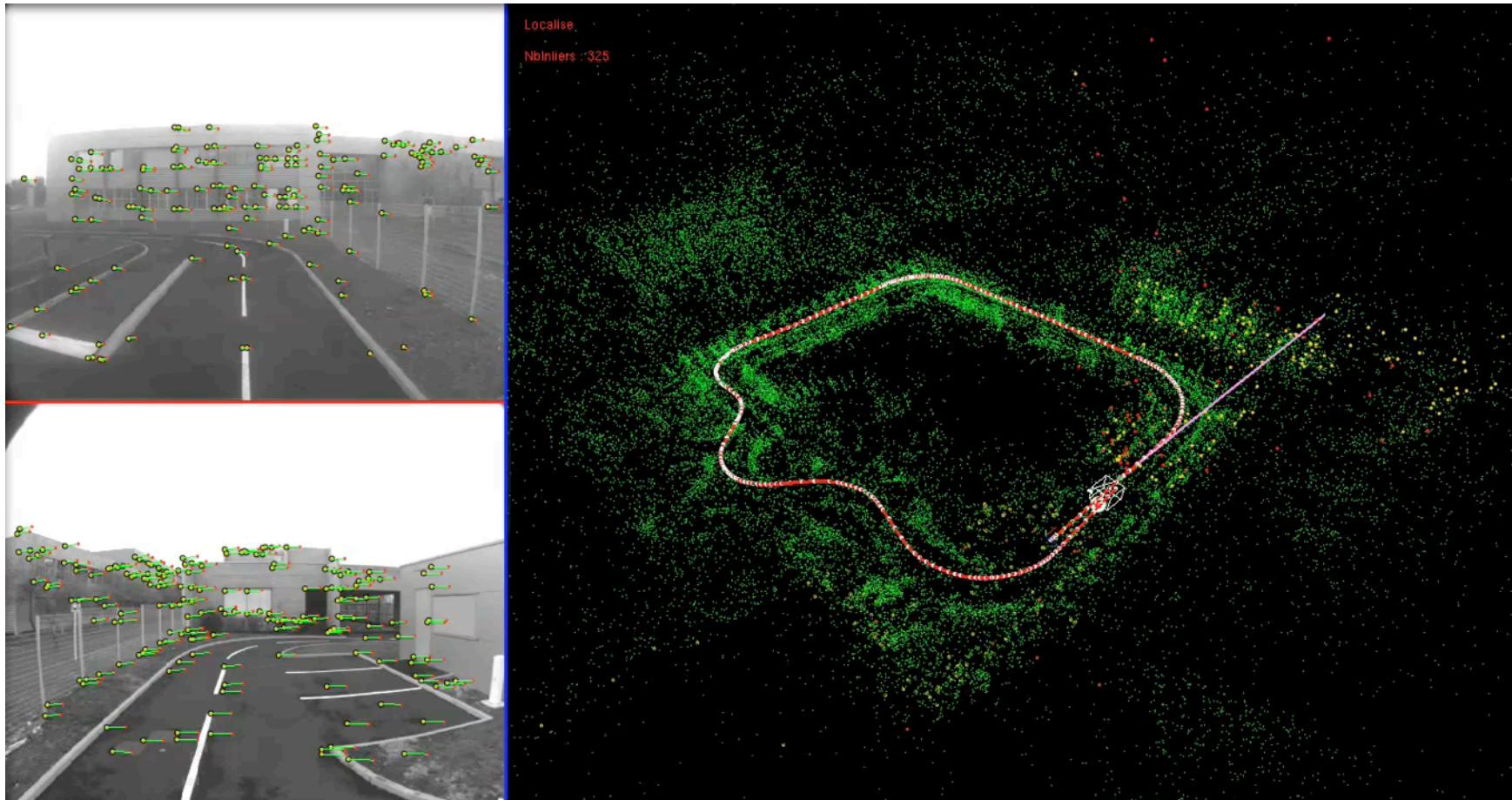
Step 2: 3D reconstruction



(125 m, 172 key images, 23000 3D points)

Monocular based localisation for automatic guidance

Toward the Vipa Project: using two cameras (rear-front)

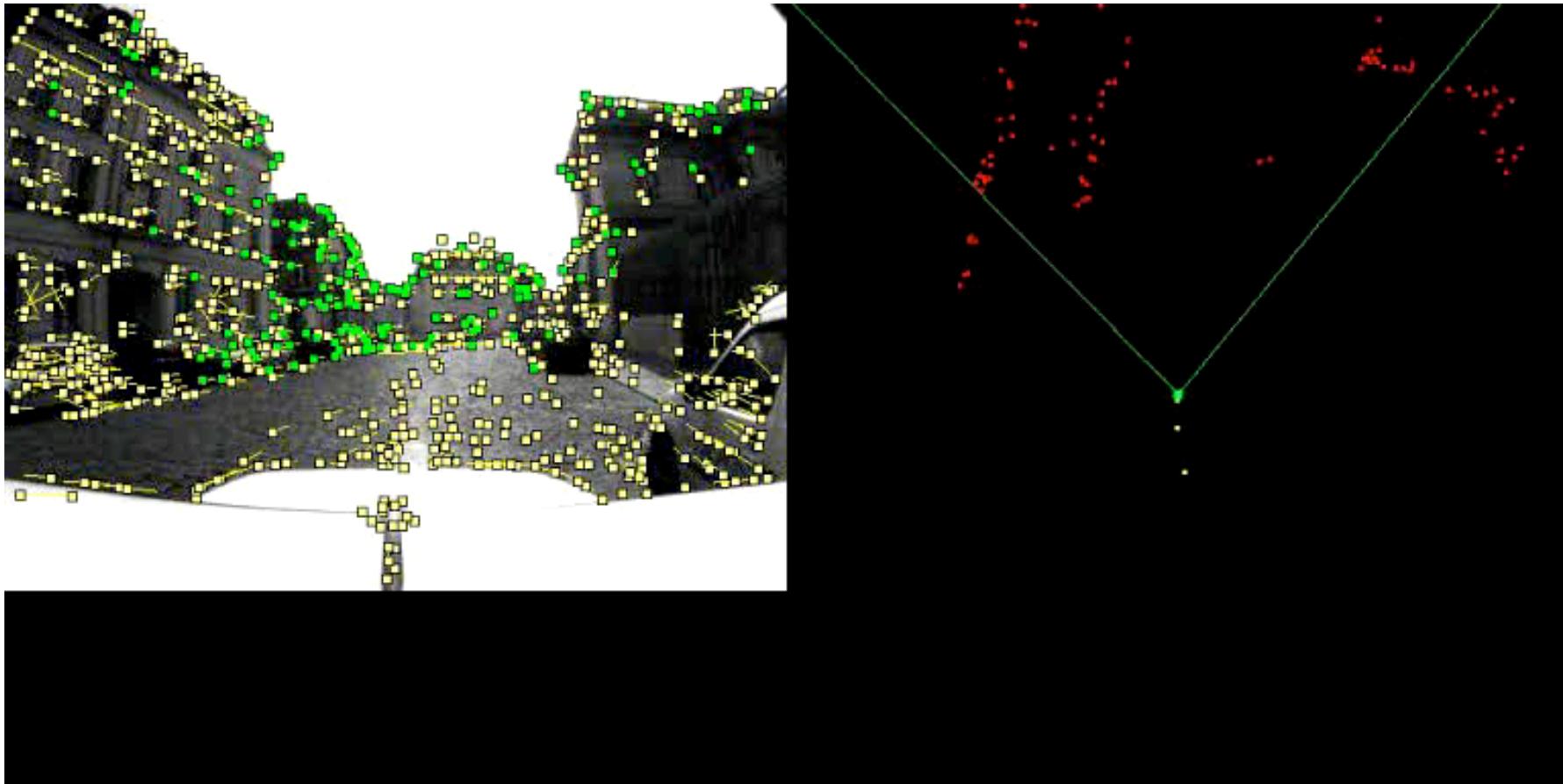


ISPR/COMSEE: 3D-LOCALISATION

Toward the Vipa Project



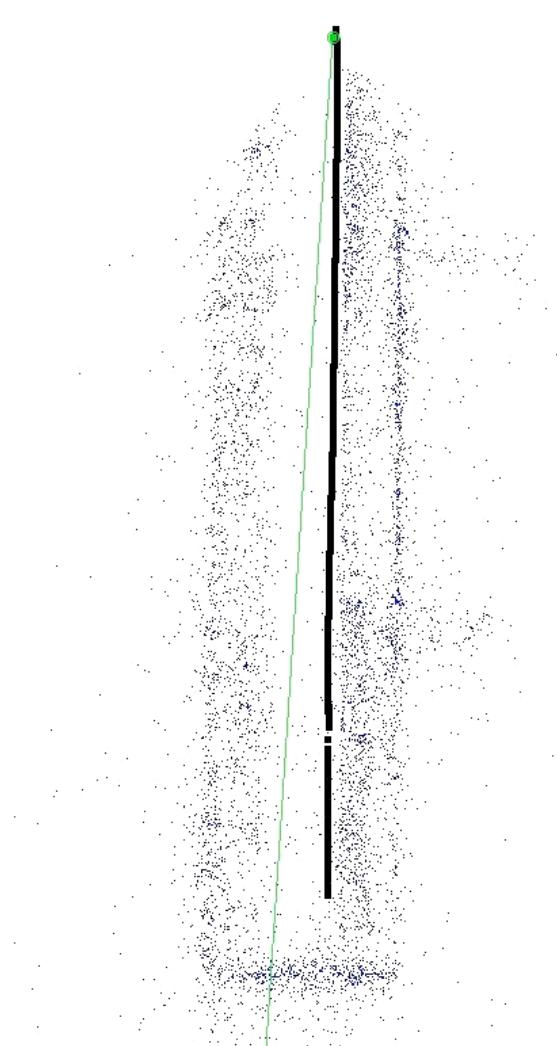
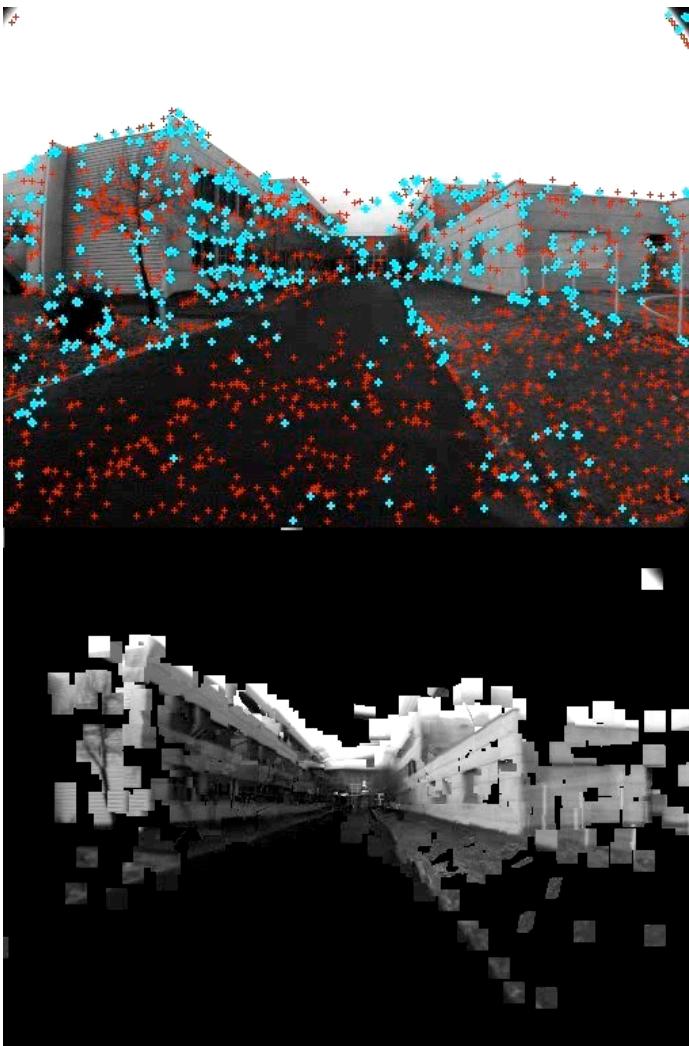
Visual SLAM: realtime 3D-reconstruction and localisation, in collaboration with CEA



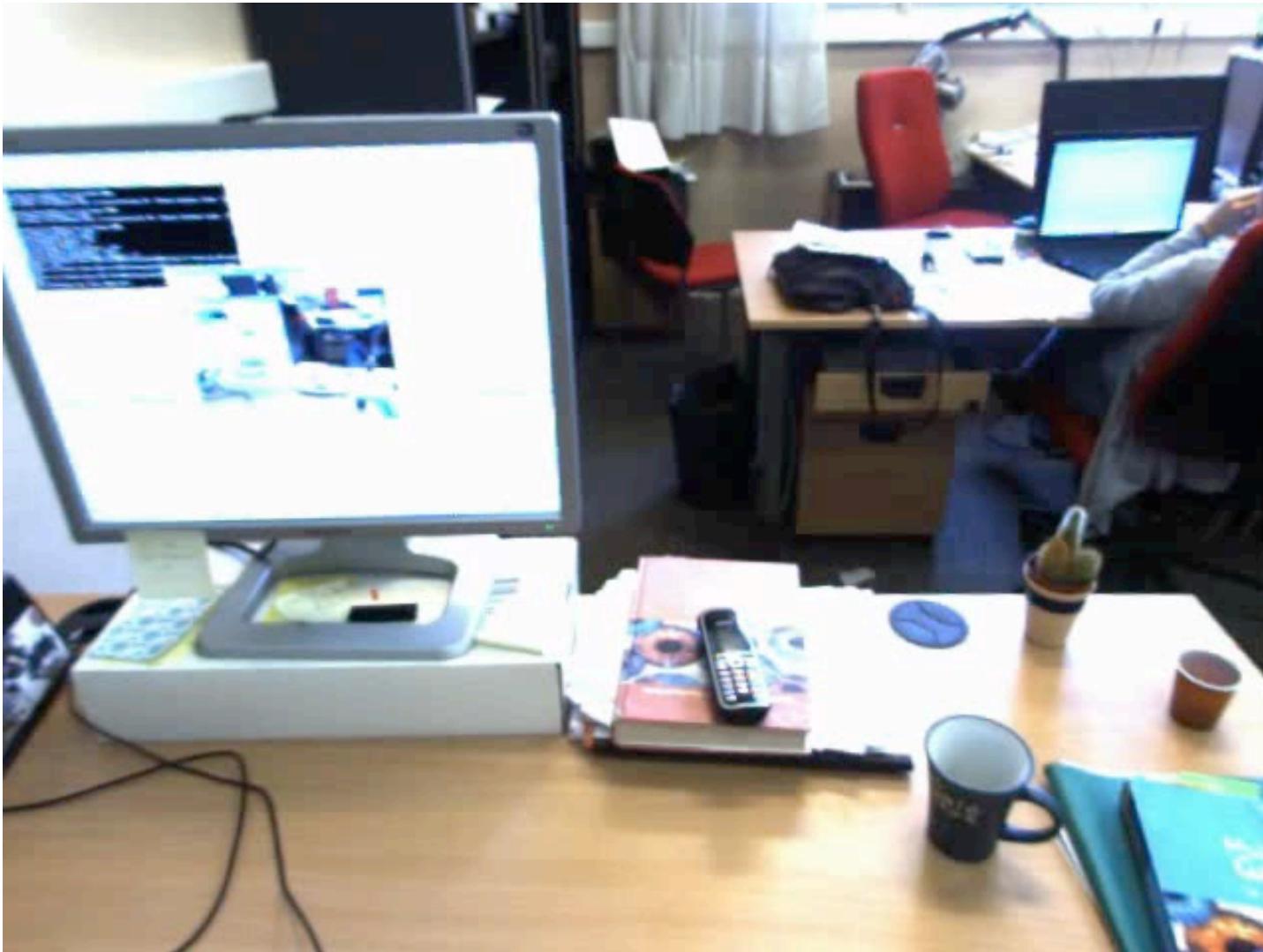
Visual SLAM: realtime 3D-reconstruction and localisation, collaboration with CEA



Visual localisation: the problem of robust interest points matching



Visual SLAM: realtime 3D-reconstruction and localisation, collaboration with CEA



Visual SLAM: realtime 3D-reconstruction and localisation, collaboration with CEA



CONTENT

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- **Topic 2 : Visual Identification and Tracking**

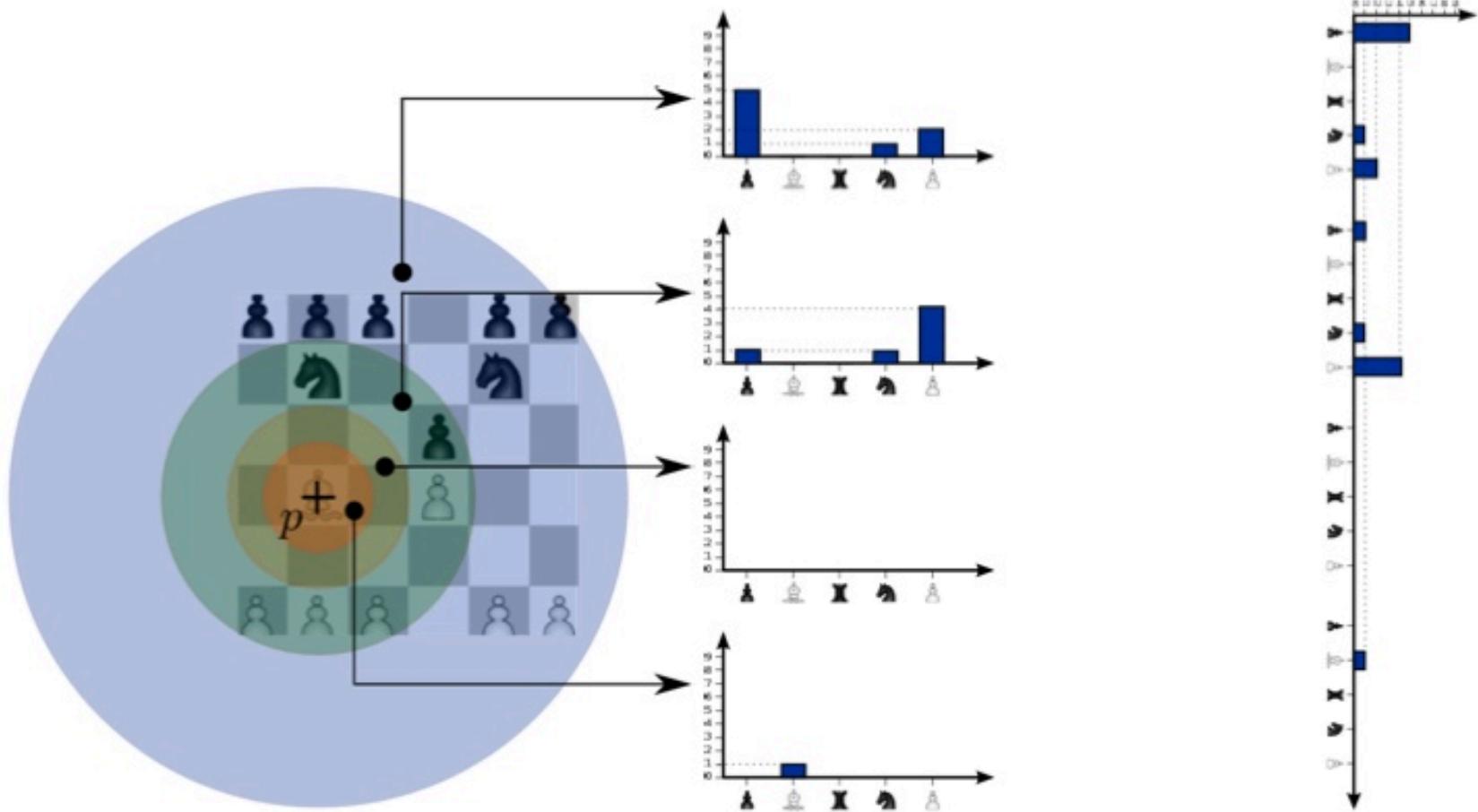
Members (permanent)

- T. Chateau, (7 PhDs (co)-supervision)
- F. Chausse, (3 PhDs (co)-supervision)
- C. Blanc, (2 PhDs (co)-supervision)
- C. Tilmant, (2 PhDs (co)-supervision)

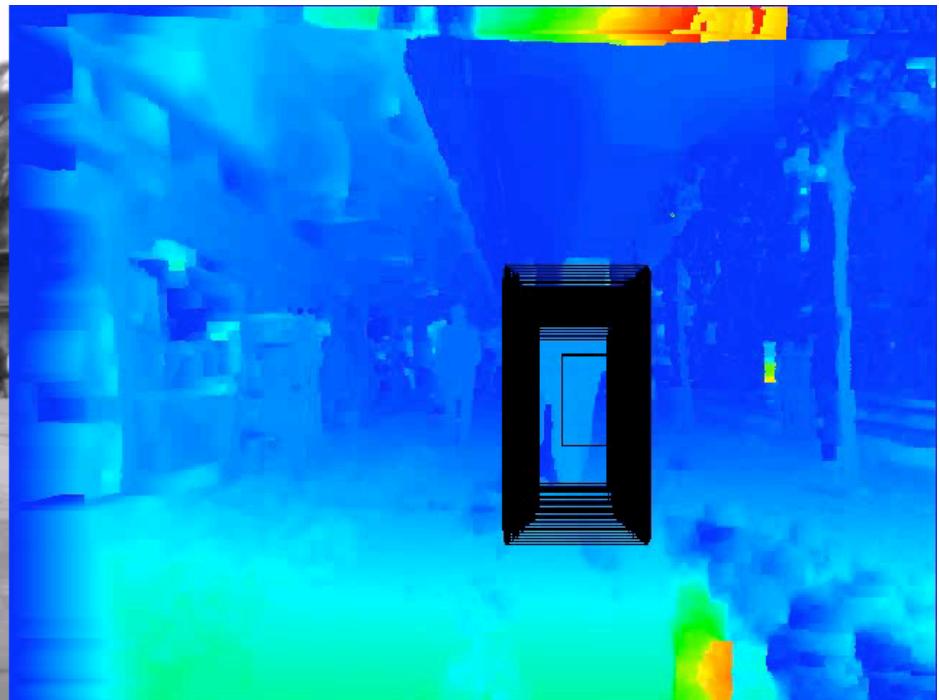
Roadmap

- **Detection**
 - machine learning algorithms for object detection in video sequences
 - specialisation of detectors
 - realtime categorisation
- **Tracking**
 - non overlapping multi-camera tracking
 - realtime dense tracking (high number of objects)

Semantic Context Based-Descriptor



Machine learning for visual detection (stereo), in collaboration with CEA



VISUAL IDENTIFICATION AND TRACKING

Global video analysis for automatic thumbnail collection generation: in collaboration with

VESALIS
visual simulation

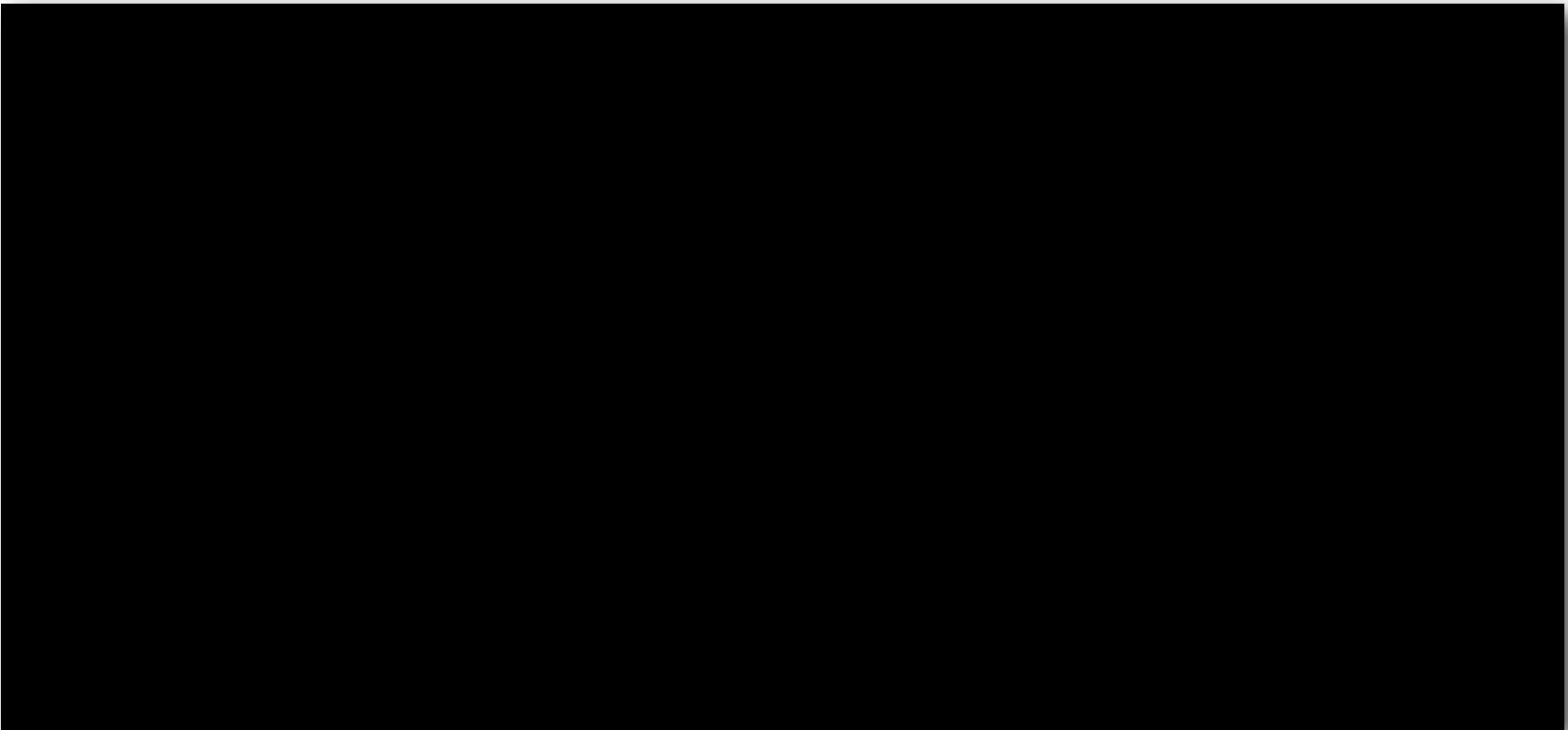


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VISUAL IDENTIFICATION AND TRACKING

Robust Face Detection



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Visual tracking: learning based planar tracking

- Context
 - realtime planar tracking
 - textured templates
 - tracking from a static or moving camera
- Relevant features
 - a kernel based regressor approach
 - applications to smartphones based augmented reality



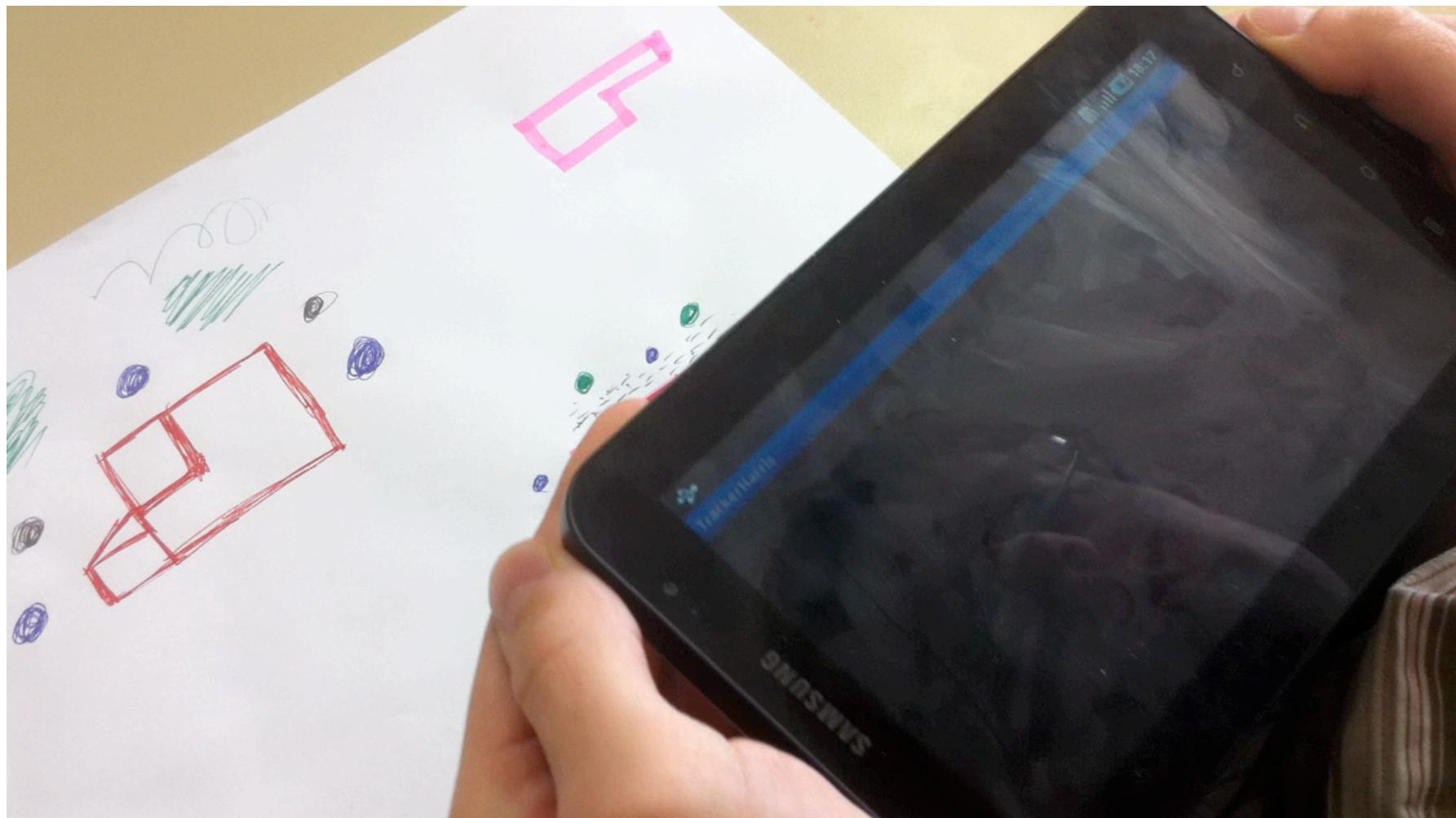
VISUAL IDENTIFICATION AND TRACKING

Visual tracking: Application to augmented reality



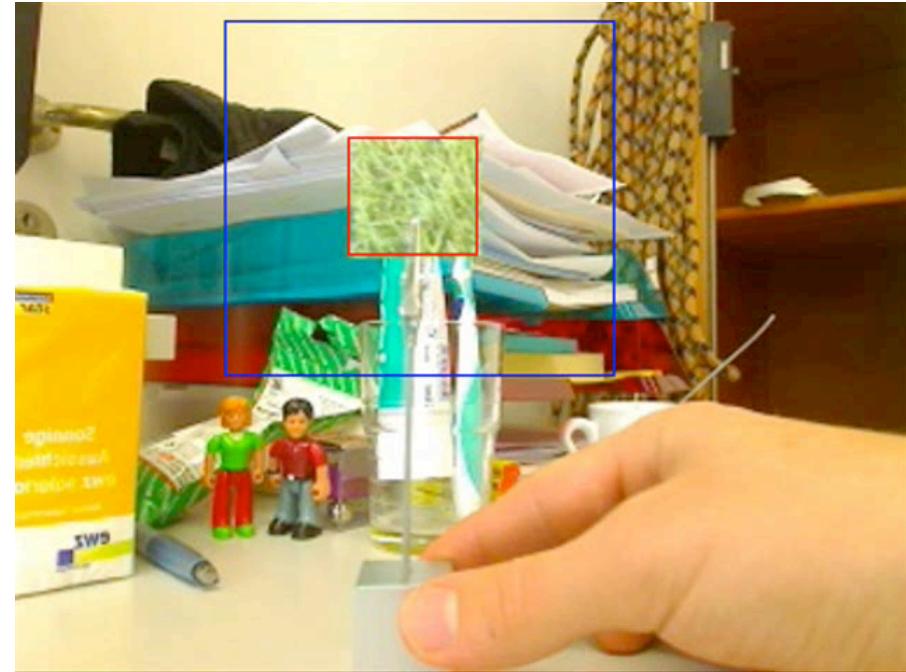
VISUAL IDENTIFICATION AND TRACKING

Visual tracking: Application to augmented reality



Visual tracking: machine learning based tracking, in collaboration with Prynél

- Context
 - robust object tracking
 - real-time tracking
 - tracking from a static or moving camera
- Relevant features
 - Ensemble tracking algorithm
 - Joint particle filter (both position/ weight of detection modules are explorated)



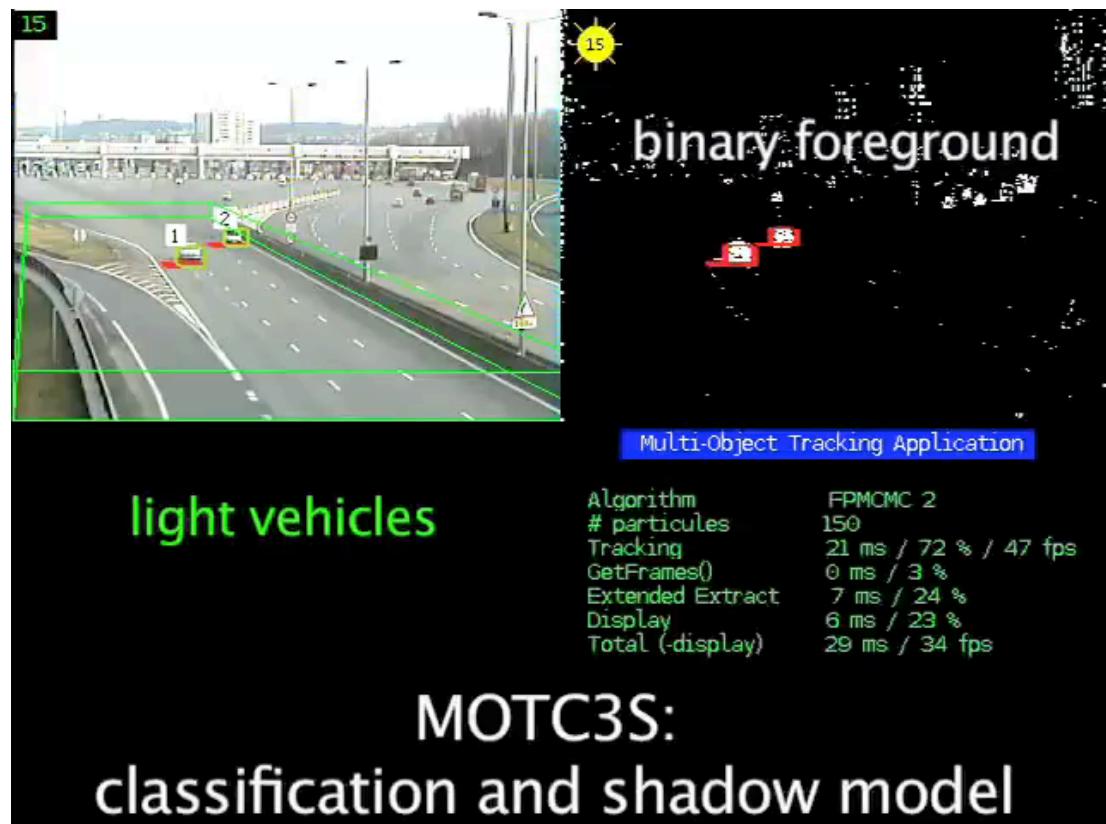
Visual tracking: simultaneous categorisation and tracking

- Context

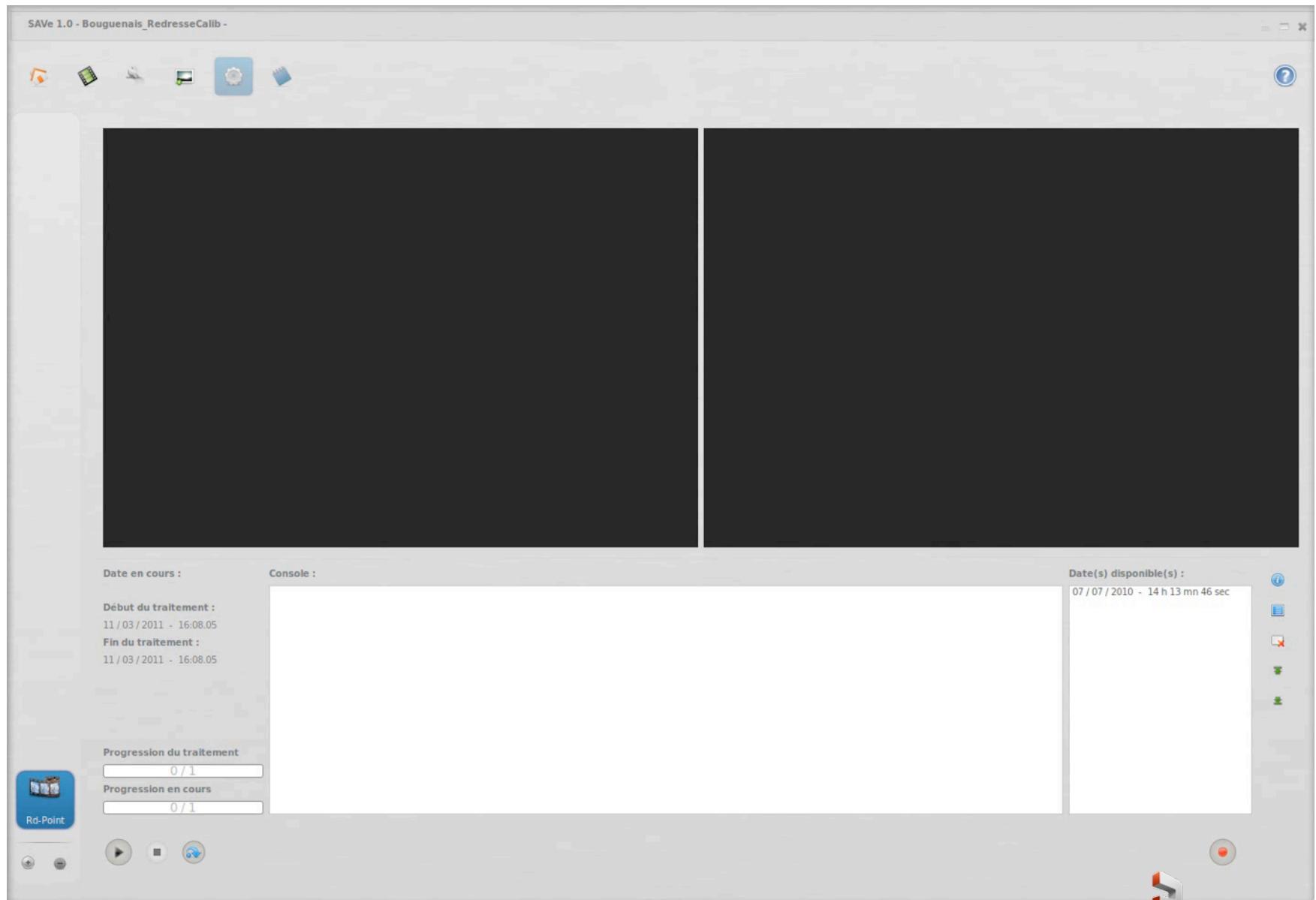
- realtime scene tracking
- tracking from a static camera
- track a variable number of objects

- Relevant features

- a sequential particle filter algorithm
- observation function is based background/foreground extraction
- sun tracking



VISUAL IDENTIFICATION AND TRACKING

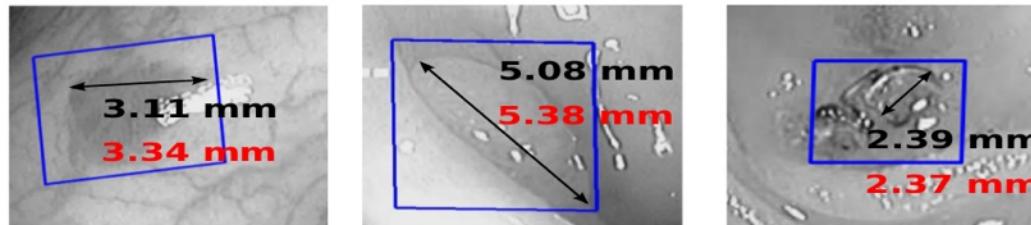


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Mesure *in-vivo* en coloscopie (C. Tilmant)

- Approche active : Lumière structurée
- Estimation dense de la profondeur par vision active
- Approche passive: Estimation de l'échelle de la scène
- Shape-from-Defocus & Structure-from-Motion



Financements:

- Projet ANR TecSan (SYSEO 100k€)
- BI région (45k€ ⇔ 1 CDD/12 mois)
- FRI 2 (80k€ dont 1 CDD/18 mois)



Personnels:

- 1thésard (F. Chadebecq) & 1post-doc (T. Collins)

Perspectives:

- Nouveaux financements pour 2014 (EU ou ANR)

Partenaire Industriel :

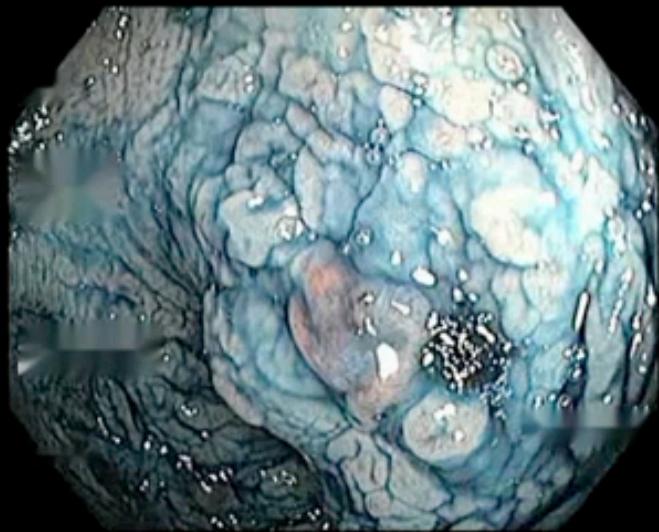


Narrow Band Imaging Facilitates Dense 3D Reconstruction in Colonoscopy

Submitted to ISBI 2013

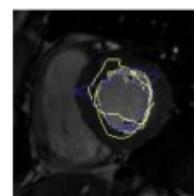
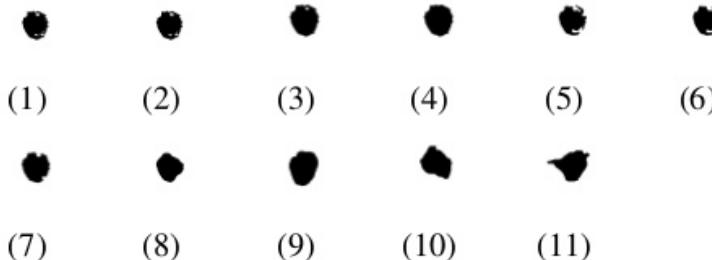
Narrow Band Imaging Facilitates Dense 3D Reconstruction in Colonoscopy

- Experiment 1

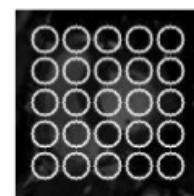


Imagerie Cardiaque (C. Tilmant, F. Chausse)

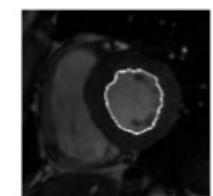
- Segmentation multimodalité
- Approche variationnelle
- Evaluation de la segmentation sans vérité terrain
- Forme mutuelle et *extended Regression Without Truth*
- Actions GDR STIC Santé (IMPEIC, MediEval, GRIC)



(a) N contours



(b) Contour initial



(c) Forme mutuelle

Financements:

- Projet ANR TecSan (3DSTRAIN 175k€)

Personnels:

- 1thésard (C. Beitone) & 1post-doc (2013)

Perspectives:

- Recrutement de personnel (Bourse ministérielle)

