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# Senior Research Scientist
# 3D Computer Vision

## Employment

2000– **Research Scientist** (INRIA, Sophia-Antipolis & Grenoble, France)
(French National Institute for Research in Computer Science),
Research in surgical robotics (2000-2002), computer vision (2002-2015) and computer graphics (2016-).

1999–00 **Lecturer** (Univ. Nice Sophia-Antipolis, France)
within the Computer Science Department (teaching BSc and MSc).

1996–99 **Research and Business Engineer** (Airbus Defence and Space Geo-Intelligence, formerly Istar, Sophia-Antipolis, France),
in an INRIA startup founded in 1988, which produces and sells 3D cartographic data made from aerial and satellite imagery : digital terrain models, land cover data, ortho-images. nternal and collaborative research funded by institutional or industrial partners. Responsible for the prospection and proposal of financed studies (target of 380k€ in 1999).

## Education

1993–97 **PhD in Algorithmics** (École Polytechnique, France) *summa cum laude*
*Stereoscopic Vision and Differential Properties of Surfaces*,
Supervisor : Olivier Faugeras.
*Jury :* Stéphane Mallat (President, École Polytechnique), Olivier Faugeras (INRIA), Michael Brady (Oxford), Pascal Fua (EPFL), Nicholas Ayache (INRIA), Rachid Deriche (INRIA), Laurent Renouard (Istar).

*Brief Synopsis of Research :* This research deals with several aspects of stereoscopic computer vision, which consists of reconstructing a scene observed from several cameras in 3-D, i.e. to build a description of the observed objetcs ans surfaces, and their position in 3-D space. The first problem we introduced is the camera calibration problem, where the goal is to compute the camera parameters (focal length, optical center, etc.) and their position, either from images of a calibration object or automatically (the last case is the so-called self-calibration problem). We presented new results on self-calibration of optical distortion and on self-calibration of a rigid stereo rig from several pairs of images. Then we discussed on image rectication, which simplifies a lot the stereo matching problem, and on stereoscopy by correlation, which performs the pointwise image matching. We got very good results using some classical methods, and we also developped new methods which give a better accuracy. The last step of stereoscopic vision, called the reconstruction, gives a 3-D description of a surface and its differential properties up to order 2 from the results of the correlation methods. Finally, we showed a few applications, like a system for fusing stereo images with volumetric medical images, and a DIY stereo camera.

1992–93 **MSc in Computer Science** (Univ. Nice Sophia-Antipolis, France) *summa cum laude*
Theory and Applications of Computer Vision and Robotics.
Master's thesis (at INRIA, France) : *Computing differential properties of 3-D shapes from stereoscopic images, without explicit 3-D reconstruction.*

1992 **Engineering Degree from École Polytechnique, France**
Majors *Materials science* and *Fundamental Computer SCience and Applications.*
Internship in University of Illinois at Urbana-Champaign, USA (4 months) : *Conception of a 3-D model for Face Recognition.*

Since 2016, within the IMAGINE team at INRIA/LJK, my research was on producing immersive media, especially 360° video (collaborative project FUI LIVE360TV) [Nab18] and image-based rendering from multiple cameras (PhD funded by INRIA/DGA) [NDC16,NDC17,Nie17]. I also contributed to the research work on automatic movie reframing and movie editing.

From 2007 to 2015, in the PRIMA team at INRIA/LIG, I worked mainly on two subjects : low-level scale-invariant computer vision, and applications of 3D computer vision to immersive and 3D media production, post-production, and broadcast (movies, sports and cultural events) [DB10,DD10,DDR11,DLD12,DPC12,Puj15]. The first subject was focused on extraction meaningful 3D motion information from stereoscopic or RGBD cameras [HD07,Hug09,QDC12,QDC13,Qui14]. The second subject has been going on since 2005 within several collaborative projects with Orange, Technicolor, Instutut Mines-Télécom, Binocle, and AMP Visual (ANR Stereocam Super HD, FUI 3DLIVE, FUI ACTION 3DS). Two software licence transfer agreements were signed with Binocle in 2008.

From July 2002 to March 2007, my research focused on 3D computer vision using a large number of cameras, with the primary goal of extracting 3D motion data from video footage. This work includes the acquisition and calibration of multi-camera video streams using a compute cluster [GS04,Amo06], multi-view 3D reconstruction and scene flow computation (the 3D version of optical flow) [Hug08,Hug05], 3D tracking of points of interest or surface elements [DMG06], and motion capture with and without markers using deformable or articulated models (face, hand, body) [Dew05,DDH06,DDHF06,KRHD06]. During this period, I also designed and developed with engineers a synchronized multi-camera acquisition system for real-time processing. This system has been marketed since 2007 by the company 4DViews, and equips the Kinovis platform available at INRIA Grenoble Rhône-Alpes.

From September 1999 to January 2002, I carried out my research within the ChIR team at INRIA Sophia-Antipolis, on the theme of surgical robotics, more particularly on the reconstruction of the coronary tree of a beating heart from cine-angiography [SDC+03,BMV+03,BVD+02,SDCM02], and on using computer vision for augmented reality during cardiac surgery [ DMC01,MD+01]. The team, including members of several INRIA teams (Robotvis, Epidaure, Prisme) also included industrials (Intuitive Surgical and General Electric Medical Systems) and Pr. Alain Carpentier's team at Hôpital Broussais (Paris). This research led to mseveral publications and to a PhD contract with General Electric Medical Systems.

Within the R&D department of the French company Istar (an INRIA startup, now part of Airbus Defence and Space Geo-Intelligence), I carried out research on the techniques allowing to obtain 3D digital elevation models of cities from high-resolution aerial or spatial imagery [Ves00,DD99,VD99,VD00,VD01,DV06], and the simultaneous calibration of hundreds of cameras.

During my PhD thesis [D97], I was interested in various topics related to stereoscopic computer vision : stereo by correlation with implicit calculation of surface normals and curvatures [DF94a], autocalibration of a stereoscopic system [DF96], calibration of nonlinear distortion [DF95a]. I took part in a joint experiment with INRIA's Epidaure and RobotVis tems, using stereoscopic vision and MRI for augmented reality [BFAD95].

### Scientific community activities

Deputy Scientific Director (2009 to 2014) of GdR 720 ISIS `http://gdr-isis.org` (a virtual laboratory regrouping all French researchers in Signal Processing and Computer Vision), responsible for the "Vision, 3D Geometry, Motion" theme. Organization of 1-day scientific workshops (6 per year).

Co-organisation with Peter Sturm of the ORASIS conference (young French researchers in computer vision) 2011 in Praz-sur-Arly.

Member of the organizing committee *(demo chair)* of ECCV 2008 (10th European Conference on Computer Vision), Marseille, France.

Member of the pre-proposal evaluation committee (CEP) for ANR (French National Research Agency) in 2013, evaluation of 30 pre-proposals.

Evaluation expert for ANR (French National Research Agency) and RIAM (Research and Innovation in Audiovisual and Multimedia) agencies.

Member of the program committee and reviewer for ECCV (2012-2018), IEEE CVPR (2012-2018, 1999), PG (2016), 3DV (2015-2016), ICCV (2015, 2013, 2009, 2005, 2003), ICPR (2014, 2012), ACM SIGGRAPH (2017, 2013, 2010), BMVC (2017-2018,2012), CVMP (2015, 2013), ICVS (2011), RFIA (2016, 2012, 2010, 2008).

Regular reviewer for international journals : IEEE PAMI (2002-2006, 2013-2015), IJCV (2010), IVC (2011), Optics Express (2013), IMAGE (2010), MEDIA (2006), JEI (2014).

Member of the organizing committee *(registration chair)* of the workshop IEEE MMSP'01 (Workshop on Multimedia Signal Processing), October 2001, Cannes (125 attendees).

### Contracts

2015-2018 : CIFRE PhD contract between INRIA and Siléane. Responsible for INRIA.

2015-2018 : FUI contract *Live 360 TV* with partners INRIA, Ateme (leader), Kolor, Aviwest, Arkamys, Telecom ParisTech. Responsible for INRIA.

2012-2015 : FUI contract *Action 3DS* with partners INRIA, Binocle, Device-ALab, ENS Louis Lumière, e2v, GREYC, Lutin, Thalès Angénieux (leader).

2008-2012 : FUI contract *3DLive* with partners INRIA, Binocle, AMP Visual, Orange (leader), Institut Mines-Télécom, Technicolor, Thalès Angénieux. Responsible for INRIA.

2005-2008 : ANR RIAM contract *Stereocam Super HD* with partners INRIA, Binocle (leader), DxO Labs. Responsible for INRIA.

2005-2008 : CIFRE PhD contract between INRIA and Renault SA. Responsible for INRIA.

2005-2008 : ANR Masses de Données (Big Data) contract with partners INRIA (leader) and Geosciences Azur. Responsible for INRIA.

1997-2000 : CIFRE PhD contract between INRIA and Istar SA. Responsible for Istar.

### Software and industrial transfer

Author of the open-source video compositing software Natron (600k lines of code) (2013-2018).

Active contributor to many open-source software (Bino3D, MacPorts, Mesa, AUC-TeX, GNOME, Octave...), see also `https://www.openhub.net/accounts/devernay`.

Author of software libraries for monitoring 3D movie shooting and real-time rectification of stereoscopic video for broadcast, integrated into the products DisparityTagger and DisparityKiller sold by the company Binocle (2008).

Conception and realization of a multi-view video capture and processing software using a compute cluster, transfered to the INRIA startup 4D View Solutions (2007), sold under the product name 2DX Multi-Camera.

Feasability study for a vehicle parking assistance system for IMRA Europe (2000).

Dense 3D reconstruction by stereoscopy software, transfered to RealViz, now AutoDesk (1999).

Engineering of a mirror-based single camera acquisition system [MD95].

Contributor to the Tsai camera calibration software, by Reg Willson (3M/CMU).

My teaching experience focuses on courses that are either theoretical – the topics may be general (algorithmic) or related to my research topics (image processing, computer vision, remote sensing) – or technical (Unix, C / C ++, OpenGL, HCI. ..). The technical courses are usually taught to younger and less specialized students, and are motivated by the possibility to attract them to research or industry by showing practical applications.

2008– **INPG/CPP** (Grenoble) : Lectures and tutorials on *Computer Science* (51/yr) to undergraduate students. Based on the Caml programming language from 2008 to 2013, then Python.

2005–12 **ENSIMAG** (Grenoble) : Lectures and tutorials (42h/yr) on *Algorithmics* to Master's students without a Computer Science degree.

2001–11 **ENSG** (Marne-la-Vallée) : Lectures (14h/yr) on *3D Computer Vision and Stereoscopy* in a Masters degree specialized in photogrammetry (MS PPMD).

2001–02 **ESINSA** (Sophia Antipolis) : Lectures and tutorials (33h) on *3D Computer Vision* to Masters students preparing an Engineering degree.

1998–02 **ESSI** and **DESS Télécom** (Sophia Antipolis) : Tutorials (36h/yr) on *Real-time computer graphics with OpenGL* and tutorials (20h/yr) on *3D graphics techniques* for Master's students.

2000–01 **CERAM** (Sophia Antipolis) : Lectures (12h/yr) on *Using Unix* to Master MBDS students.

1999–00 **Université de Nice** : Lectures and tutorials (61h) on *Human Computer Intefaces*, theoretical (cognitive sciences, ergonomy) and practical (programming with a GUI toolkit), to Masters students, with a complete rewrite of the course content. Many lectures and tutorials in the Computer Science department (114h).

1996–00 **ESSI** (Sophia Antipolis) : Lectures and tutorials (40h/yr) on *Internet and the World Wide Web : system aspects and programming.*

1997–98 **GDTA** (Toulouse) and **Université de Nice** (Sophia Antipolis), Master Aravis : Lecture on *Producing Digital Terrain Models Using SPOT Stereoscopy, SAR Interferometry, and Radargrammetry* (13h).

1994–96 **Lycée International de Valbonne** (Sophia-Antipolis) : Khôlleur (oral examiner) in Mathematics in CPGE (highly selective classes to prepare for the competitive exams to the Grandes Écoles) (60h).

### PhD Graduates

[Nab18] Supervisor of Sandra Nabil (Université de Grenoble Alpes), *High resolution panoramic video creation and processing*, advised by James Crowley (LIG, Grenoble), defense planned in Nov 2018.

[Bre18] Supervisor of Romain Brégier (Université de Grenoble Alpes), *Detection and pose estimation of instances of a rigid object for robotic bin-picking*, advised by James Crowley (LIG, Grenoble), defended in Jun 2018.

[Nie17] Supervisor of Grégoire Niéto (Université de Grenoble Alpes), *Light field remote vision*, advised by James Crowley (LIG, Grenoble), defended in Oct 2017 `https://tel.archives-ouvertes.fr/tel-01675769`.

[Puj15] Supervisor of Sergi Pujades-Rocamora (Université de Grenoble), *Camera models and algorithms for 3D video content creation*, advised by Rémi Ronfard (LJK, Grenoble), soutenance en octobre 2015 `https://tel.archives-ouvertes.fr/tel-01281363`.

[Qui14] Supervisor of Julian Quiroga (Université de Grenoble), *Scene flow estimation from RGBD images*, advised by James Crowley (LIG, Grenoble), defended in Nov 2014 `https://tel.archives-ouvertes.fr/tel-01097763`.

[Dec13] Supervisor of Marion Decrouez (INPG), *Visual SLAM in indoor environment*, advised by James Crowley (LIG, Grenoble), defended in May 2013 `https://tel.archives-ouvertes.fr/tel-00953269`.

[Hug09] Co-supervisor of Frédéric Huguet (INPG), *Mathematical modelling and computation of the stereoscopic scene flow with a variational method*, co-supervised by Éric Bonnetier (LMC, Grenoble), defended in Apr 2009 `http://tel.archives-ouvertes.fr/tel-00421958/`

[Mor08] Scientific supervisor of Julien Morat (INPG), *Stereoscopic computer vision for target detection and tracking applied to automotive*, advised by Radu Horaud (INRIA, Montbonnot), CIFRE PhD (industrial) between INRIA and RENAULT S.A, defended in Jul 2008 `http://tel.archives-ouvertes.fr/tel-00343675/`.

[Dew05] Co-supervisor of Guillaume Dewaele (INPG), *Modeling, tracking and simulation of articulated and deformable objects : applied to the real sculpting of a virtual clay*, on the part that deals with 3D hand tracking, co-supervised by Radu Horaud and Marie-Paule Cani (INRIA, Montbonnot), defended in Dec 2005 `http://tel.archives-ouvertes.fr/tel-00584946/`.

[Mou03,Blo04] Co-supervisor of Fabien Mourgues (ENS Cachan), *Guidance by augmented reality in robotically assisted cardiac surgery*, `http://tel.archives-ouvertes.fr/tel-00346341/`, and Christophe Blondel (UNSA, Nice), *3D and 3D+t modelling of coronary arteries from rotational sequences of x-ray projections*, `http://tel.archives-ouvertes.fr/tel-00346997/`, from Sep 2000 to Jan 2002, advised respectively by Olivier Faugeras and Nicholas Ayache (defended in Sep 2003 and Mar 2004).

[Ves00] Industrial and scientific supervisor of Christophe Vestri (UNSA, Nice), *Tools for automatic building modeling with aerial imagery*, advised by Olivier Faugeras, CIFRE PhD (industrial thesis) between INRIA and Istar/Airbus Defence and Space Geo-Intelligence (defended in Sep 2000) `http://tel.archives-ouvertes.fr/tel-00346358/`.

**Master's Graduates**

[Arq12] *Automatic certification of 3D movies*, Pierre Arquier (M2R MOSIG), Jun 2012.

[Boi12] *Stereoscopic video copy-and-paste*, Laurent Boiron (M2R MOSIG), Jun 2012.

[Ram10] *View Interpolation for Stereoscopic Cinema*, Adrian Ramos-Peon (M2R MOSIG), Jun 2010.

[Amo06] *Multi-Camera Color Calibration*, Thomas Amory (ASI ENSIMAG), Sep 2006.

[Hug05] *Dynamic 3D Reconstruction by Stereoscopy and Applications to Geology*, Frédéric Huguet (Master Recherche Mathématiques Appliquées, UJF, Grenoble), Jun 2005.

[Pic04] *Motion Capture with Retro-reflecting Markers*, Yohann Piccoli (Master Recherche Imagerie Vision Robotique, INPG, Grenoble), Sep 2004.

[GS04] *Multi-Camera Video Production Unit*, Florian Geffray and Élodie Sannier (Master Pro Génie Informatique, UFJ, Grenoble), Sep 2004.

[PH03] *Synchronization of a Camera Network on a PC Cluster*, Fabien Philippe and Bertrand Holveck (ASI ENSIMAG), Sep 2003.

[Mou00] *3D Reconstruction of Coronary Arteries for Augmented Reality in Cardiac Surgery*, Fabien Mourgues (ENS Cachan/DEA Aravis, Nice), 2000.

[Hew99] *Real-Time Visualization of 3D Catrographic Data Using VRML*, Marcus Hewat (DESS Image et Réseau, Lyon), 1999.

[Mes99] *3D Vectorization of Urban Digital Elevation Models*, Marion Mesnage (X/ENSTA, Paris), 1999.

[Ran98] *C++ Refactoring of a Multi-Sensor Camera Calibration Software*, Cécile Rangheard (ESSI, Nice), 1998.

[Car98] *Study On Electromagnetic Wave Propagation Models for Mobile Phone Networks*, Pasqualino de Carolis (EPFL, Lausanne & Politecnico di Torino), 1998.

[Row97] *C++ Library for Airborne and Spatial Sensor Models*, Lucian Rowe (ESSI, Nice), 1997.

[Ves97] *Semi-Automatic Extraction of Urban Digital Elevation Models From High-Resolution Aerial and Spatial Imagery*, Christophe Vestri (DEA Aravis, Nice), 1997.