

## CURRICULUM VITAE

---

# Jesús Angulo

---

### Associate Researcher

Centre de Morphologie Mathématique  
Ecole des Mines de Paris  
35, rue Saint-Honoré  
77305 Fontainebleau, FRANCE  
Tel. : + 33 (0) 1 64 69 47 75  
Fax. : + 33 (0) 1 64 69 47 07  
E-mail : [angulo@cmm.ensmp.fr](mailto:angulo@cmm.ensmp.fr)  
Web : <http://cmm.ensmp.fr/~angulo/>



## PERSONAL DETAILS

- *First Name:* **Jesús**
- *Surname:* **Angulo López**
- *Date and Place of Birth:* **28 April 1975** in Cuenca, **SPAIN**
- *Residential Address:*  
**8, Aristide Briand,**  
**F-77300 Fontainebleau, FRANCE**
- *Phone Number:* **+ 33 (0) 1 60 72 15 96**
- *E-mail:* [carlinjes\\_angulo@hotmail.com](mailto:carlinjes_angulo@hotmail.com)
- *Nationality:* **Spanish**
- *Languages:*
  - **Spanish:** mother tongue
  - **French:** good
  - **English:** good
- *Marital Status:* **Married, two daughters**

## EDUCATION

- **Ph.D. studies in Image Processing (Mathematical Morphology) (1999-2003):** Ecole des Mines de Paris, France, at the Centre de Morphologie Mathématique. Dissertation with highest honours (“Très Honorable avec les Félicitations du Jury”)  
*Thesis Advisor:* Prof. Jean Serra  
*Dissertation:* Mathematical morphology and colour image indexing. Application to microscopy in biomedicine  
*Committee:* Prof. A. Albiol, Prof. A. Trémeau, Prof. G. Flandrin, Dr. J. Klossa, Dr. F. Vallet and Prof. J. Serra
- **Master Thesis (1999):** Universidad Politécnica de Valencia, Valencia, Spain, at the Image and Video Processing Group. Dissertation with highest honours (“Matricula de honor”)  
*Thesis Advisor:* Prof. Antonio Albiol,  
*Research Area:* Temporal segmentation of video sequences

- **M. Eng. in Telecommunication Engineering (1993-1999):** School of Telecommunications Engineering, Universidad Politécnica de Valencia, Spain, diploma received in October 1999
- **Secondary school (1989-1993):** At the “Instituto C.E.I.” in Albacete, Spain. Diploma with highest honours
- **Primary school (1981-1989):** At the “Colegio Público Juan Angel Sevilla” in Honrubia, Cuenca, Spain. Diploma with highest honours

## NOMINATIONS

One of the 10 finalist for the ParisTech price for the best Ph.D. in 2003 (ParisTech is a consortium of the teen most prestigious Graduate Engineering Institutes in France)

## PROFESSIONAL EXPERIENCE

**Since January 2004 Associate Researcher:** Main activity is the development of methods and software for reading biological image arrays using morphological signal and image processing algorithms (Projects GEMBIO and INDIGO). Including teaching activities and supervision of students.

**November 1999 - December 2003 Research Engineer:** Research grant at the Centre de Morphologie Mathématique of the Ecole des Mines de Paris. Duties included developing and programming morphological image processing algorithms applied to biomedicine and biotechnology in the framework of several projects with industrial and academic partners. **Teaching assistant** for the practical work of the courses *Morphological Image Processing in Practice* (J. Serra) and *Ecole d’été de morphologie mathématique* (S. Beucher)

**2004/2005 Lecturer:** Lecturer of the course *Image Analysis using mathematical morphology* (18 hours) at the SUPELEC-Metz (Ecole Supérieure d’Electricité)

**Mars - April 2005, 2004, 2003, 2002 Lecturer and Teaching Assistant:** Lecturer of the course *Imagerie médical* and assistant for the practical work of the course *Morphologie Mathématique* (2nd year of engineering studies) organised by A. Manzanera at the Ecole Nationale Supérieure de Techniques Avancées, Paris

**January - October 1999 Lecturer:** Teaching at the “Instituto Europeo de Formación en Nuevas Tecnologías” (private institution) in Valencia, Spain. Cours on *Programming C and C++* and *Local Area Networks*

## PROFESSIONAL SKILLS

- **Image Processing Tools:** PDI32, Micromorph, Xlim3D, Morphee
- **Programming Languages:** C, C++, Pascal, BASIC
- **Scientific Software:** MATLAB, Mathematica
- **Operating Systems:** Windows, Linux/UNIX
- **Others:** LaTeX, HTML, Office Applications (MS and others), Professional Graphical Applications

## PROJECT RESEARCH GRANTS

**Project INDIGO - European STREP in the FP6** (Aug 05/Jul 08): *Integrated Highly Sensitivity Fluorescence-based Biosensor for Diagnostic Applications.*

**Project GEMBIO - French Grant CGM** (Jan 04/Dec 04): *Mathematical methods for the analysis of biochip data: towards medical and therapeutic diagnosis and prognostic.* Supported by the Strategic Orientation Committee for the Ecoles des Mines, part of the Conseil General des Mines (CGM).

**Project MATCHCELL2 - French Grant BIO CRITT** (Jan 04/Sept 04): *Automation for the characterisation of red blood cells for colour images of peripheral blood smears.*

**Project MATCHCELL - French Grant BIO CRITT** (Jan 01/Sept 01): *Development of image processing tools for computer aided diagnosis in haematological cytology (lymphocyte characterisation).*

## OTHER SCIENTIFIC COLLABORATIONS

**INSERM U507, Hôpital Necker - Paris** (2003) Morphological quantification of aortic calcification from low magnification images.

**INSERM U428, l'Université Paris V** (2002) Application of mathematical morphology to the quantification of in vitro endothelial cell organization into tubular-like structures.

## PUBLICATIONS

### Thesis

- J. Angulo. “**Morphologie mathématique et indexation d’images couleur. Application à la microscopie en biomédecine**” (in French). Ph.D. Thesis, 341 p., Centre de Morphologie Mathématique, Ecole des Mines de Paris, France, December 2003.
- J. Angulo. “**Temporal segmentation of video sequences**” (in Spanish). Master thesis, 239 p., Polytechnic University of Valencia, Spain, October 1999.

### Journal papers

- J. Angulo, J. Serra. “**Quantitative polar representations of colour images. Modelling and Segmentation**”. Submitted, 57 p., September 2005.
- J. Angulo. “**Morphological colour image simplification by saturation-controlled regional levellings**”. Submitted, 23 p., May 2005.
- V. Naranjo, J. Angulo, A. Albiol and J.M. Mossi. “**Gradual transition detection for video partitioning using morphological operators**”. Submitted, 8 p., February 2005.
- O. Phan, O. Ivanovski, T. Nguyen-Khoa, N. Mothu, J. Angulo, R. Westenfeld, M. Ketteler, N. Meert, J. Maizel, N. Igor, R. Vanholder, B. Lacour, T.B. Drüeke, Z.A. Massy. “**Sevelamer prevents uremia-enhanced atherosclerosis progression in apolipoprotein E deficient (apoE<sup>-/-</sup>) mice**”. *Circulation (Journal of the American Heart Association)*, Vol. , No. , pp. –, 2005
- J. Angulo and J. Serra. “**Image color segmentation using bivariate histograms in luminance/saturation/hue polar color spaces**” (in Spanish). *Computación y Sistemas*, Vol. 8, No. 4, pp. 303–316 June 2005.
- Z.A. Massy, O. Ivanovski, T. Nguyen-Khoa, J. Angulo, D. Szumilak, N. Mothu, M. Daudon, B. Lacour, T.B. Drüeke and M.S. Muntzel. “**Uremia accelerates both atherosclerosis and arterial calcification in apolipoprotein-E knockout (apoE<sup>-/-</sup>) mice**”. *Journal of the American Society of NEPHROLOGY*, Vol. 16, No. 1, pp. 109–116, 2005.
- J. Angulo and J. Serra. “**Traitements des images de couleur en représentation luminance/saturation/teinte par norme  $L_1$** ” (in French). *Traitement du Signal*, Vol. 21, No. 6, pp. 583–604, December 2004.
- J. Angulo and J. Serra. “**Automatic analysis of DNA microarray images using mathematical morphology**”. *Bioinformatics*, Vol. 19, No. 5, pp. 553–562, 2003.
- J. Angulo, T. Nguyen-Khoa, Z.A. Massy, T. Drüeke and J. Serra. “**Morphological quantification of aortic calcification from low magnification images**”. *Image Analysis and Stereology*, Vol. 22, pp. 81–89, 2003.
- J. Angulo and G. Flandrin. “**Automated detection of working area of peripheral blood smears using mathematical morphology**”. *Analytical Cellular Pathology*, Vol. 25, No. 1, pp. 37–49, 2003.

### Chapters of books

- J. Angulo and G. Flandrin. “**Microscopic image analysis using mathematical morphology: Application to haematological cytology**”. In *Edited by A. Mendez-Vilas, “Science, Technology and Education of Microscopy: An overview”* (ISBN 84-607-6679-7), Vol. 1, pp. 304–312, FORMATEX Eds., Badajoz, Spain, 2003.

- J. Angulo and J. Serra. “**A mathematical morphology contribution to the analysis of DNA microarray images**”. In *V. Capasso, Editor, “Mathematical Modelling & Computing in Biology and Medicine”* (ISBN 88-7488-055-3), pp. 3–9, SOCIETÀ EDITRICE ESCULAPIO Eds., Bologna, Italy, 2003.

#### Conference contributions

- J. Angulo, B. Marcotegui. “**Sur l’influence des conditions d’éclairage dans la segmentation morphologique couleur par LPE**” (in French). In *Actes de CORESA 2005 (Compression et Représentation des Signaux Audiovisuels)*, p. –, Rennes, France, November 2004.
- J. Angulo. “**Morphological color processing based on distances. Application to color denoising and enhancement by centre and contrast operators**”. In *Proc. of the IASTED International Conference on Visualization, Imaging, and Image Processing (VIIP’2005)*, p. 314–319, Benidorm, Spain, September 2005.
- J. Angulo, S. Matou. “**Automatic quantification of *in vitro* endothelial cell networks using mathematical morphology**”. In *Proc. of the IASTED International Conference on Visualization, Imaging, and Image Processing (VIIP’2005)*, p. 51–56, Benidorm, Spain, September 2005.
- M.A. Luengo-Oroz, J. Angulo, G. Flandrin and J. Klossa. “**Mathematical morphology in polar-logarithmic coordinates. Application to erythrocyte shape analysis**”. In *Proc. of the 2th Iberian Conference on Pattern Recognition and Image Analysis (IbPRIA’2005)*, Estoril, Portugal, June 2005. Lecture Notes in Computer Science, Vol. LNCS 3523, p. 199–205, Springer, 2005.
- J. Angulo. “**Unified morphological color processing framework in a lum/sat/hue representation**”. In *Proc. of the International Symposium on Mathematical Morphology (ISMM’2005)*, Paris, France, April 2005. p. 387–396, Kluwer, 2005.
- J. Angulo. “**Mathematical morphology operators for reading radioactivity DNA array images**”. In *Proc. of the IASTED International Conference on Visualization, Imaging, and Image Processing (VIIP’2004)*, p. 802–807, Marbella, Spain, September 2004.
- J. Angulo. “**Simplification morphologique d’images couleur par critères connectifs**” (in French). In *Actes de CORESA 2004 (Compression et Représentation des Signaux Audiovisuels)*, p. 149–152, Lille, France, May 2004.
- J. Angulo and J. Serra. “**Mathematical morphology in color spaces applied to the analysis of cartographic images**”. In *S. Levachkine, J. Serra and M. Egenhofer (Eds.) Semantic Processing of Spatial Data (Proc. of the GEOPRO 2003-International Workshop Semantic Processing of Spatial Data )*, p. 59–66, Mexico City, Mexico, November 2003.
- J. Angulo and J. Serra. “**Color segmentation by ordered mergings**”. In *Proc. of the IEEE International Conference on Image Processing (ICIP’2003)*, Vol. II, p. 125–128, Barcelona, Spain, September 2003.
- F. Torres, J. Angulo and F. Ortiz. “**Automatic detection of specular reflectance in colour images using the MS diagram**”. In *Proc. of the 10th International Conference on Computer Analysis of Images and Patterns (CAIP’2003)*, Groningen, The Netherlands, August 2003. Lecture Notes in Computer Science, Vol. LNCS 2756, p. 132–139, Springer, 2003.
- J. Angulo and J. Serra. “**Morphological coding of color images by vector connected filters**”. In *IEEE Proc. of the Seventh International Symposium on Signal Processing and Its Applications (ISSPA’2003)*, Vol. 1, p. 69–72, Paris, France, July 2003.

- J. Serra and J. Angulo. “**Application of mathematical morphology to telemedicine and biotechnology: morphological characterisation of blood cells and analysis of cDNA microarrays**” (in Spanish). In *J. L. Díaz de León Santiago and C. Yañez Marquez (Eds.) Proc. of the CIARP 2002 (VII Congreso Iberoamericano en reconcimimiento de patrones)*, p. 39–50, Mexico City, Mexico, November 2002.
- J. Angulo, G. Flandrin and J. Klossa. “**Automated morphometric analysis of peripheral blood smears cells in microscopic large fields images**”. In *Proc. of the 8th Congress of the European Society for Analytical Cellular Pathology*, p. 40-41, Heracliton Crete, Greece, September 2002.
- J. Angulo and J. Serra. “**Morphological color size distributions for image classification and retrieval**”. In *Proc. of ACIVS’2002 (Advanced Concepts for Intelligent Vision Systems)*, p. 46-53, Ghent, Belgium, September 2002.
- J. Angulo and J. Serra. “**A mathematical morphology contribution to the analysis of DNA microarray images**”. In *Proc. of the 5th ECMTB (European Society of Mathematical and Theoretical Biology) 2002 on Mathematical Modeling & Computing in Biology and Medecine*, p. 113, Milano, Italy, July 2002.
- F. Ortiz, F. Torres, J. Angulo and S. Puente. “**Comparative study of vectorial morphological operations in different color spaces**”. In *Proc. of Intelligent Robots and Computer Vision XX: Algorithms, Techniques, and Active Vision*, SPIE Vol. 4572, p. 259-268, Boston, Massachusetts, USA, November 2001.
- J. Angulo, J. Serra and G. Flandrin. “**Haematological cytology image analysis and semantic indexing: Towards a global approach**”. Special Presentation. In *Proc. of the XIVth Congress of the International Society of Diagnostic Quantitative Pathology*, p. 37, Oviedo, Spain, September 2001.
- J. Angulo and J. Serra. “**Morphological texture study of the chromatin in lymphoid cells**”. In *Proc. of the IX Spanish Symposium on Pattern Recognition and Image Analysis*, Vol II, p. 423-428, Benicàssim (Castellón), Spain, May 2001.
- J. Angulo, J. Serra and G. Flandrin. “**Quantitative descriptors of the lymphocytes**”. In *Proc. of the 7th Congress of the European Society for Analytical Cellular Pathology*, p. 69-70, Caen, France, April 2001.
- A. Albiol, V. Naranjo and J. Angulo. “**Low complexity cut detection in the presence of flicker**”. In *Proc. of the IEEE International Conference on Image Processing (ICIP’2000)*, Vol. III, p. 957-960, Vancouver, Canada, September 2000.

#### Other (symposiums, seminars, tutorials, courses, etc.)

- J. Angulo and S. Matou. “**Application of mathematical morphology to the quantification of *in vitro* endothelial cell organization into tubular-like structures**”. In *4th World Congress on Cellular and Molecular Biology (CMB’05)*, Poitiers, France, October 2005.
- J. Angulo and G. Flandrin. “**Ontology-based lymphocyte population description using mathematical morphology from colour blood images**”. In *4th World Congress on Cellular and Molecular Biology (CMB’05)*, Poitiers, France, October 2005.
- J. Klossa, J. Angulo, J.-C. Cordier, G. Flandrin, E. Jullien, G. Moebst and M.A. Luengo. “**VideoCell: a teleconsensual approach for cell semiology aimed at developing automated classifications tools; application to peripheral blood cells**”. In *7th European Congress on Telepathology*, Poznan, Poland, July 2004.
- J. Angulo and J. Serra. “**Imagerie médicale et télémedecine**” (in French). *Revue des Ingénieurs-Mines*, No. 405, p. 37-38, Juillet-Septembre 2003.

- J. Angulo. “**Rôle de l’analyse morphologique sur l’image biomédicale en télémédecine. Application à l’hématologie cellulaire**” (in French). In *12ème Forum des Jeunes Chercheurs en GBM - Journées de Recherche en Imagerie Médicale*, Nantes, France, May 2003.
- J. Angulo. “**Analyse et quantification de l’image en biomédecine et biotechnologie avec des opérateurs morphologiques**” (in French). In *Cours d’imagerie médicale (2e année-2003)*, École Nationale Supérieure de Techniques Avancées, Paris, France, April 2003.
- J. Angulo and J. Serra. “**Segmentation d’images couleur, pyramides et fusion de partitions**” (in French). In *26ème Journée ISS (International Society for Stereology - France)*, Paris, France, February 2003.
- J. Angulo and S. Matou. “**Quantification morphologique de l’organisation in vitro en réseau de type capillaire**” (in French). In *26ème Journée ISS (International Society for Stereology - France)*, Paris, France, February 2003.
- F. Ortiz, F. Torres and J. Angulo. “**Aerial image segmentation using morphological color geodesy**” (in Spanish). In *XXIII Jornadas de Automática*, CD-ROM, paper ja02060 (7 pp.), La Laguna (Santa Cruz de Tenerife), Spain, September 2002.
- J. Angulo. “**Deux applications de la morphologie mathématique en imagerie biomédicale: puces à ADN et réorganisation in vitro de cellules endothéliales**” (in French). In *Cours de morphologie mathématique (2e année-2002)*, École Nationale Supérieure de Techniques Avancées, Paris, France, April 2002.
- J. Angulo and J. Serra. “**Application de la morphologie mathématique à l’analyse des images des puces à ADN**” (in French). In *25ème Journée ISS (International Society for Stereology - France)*, Paris, France, February 2002.
- J. Angulo, G. Flandrin, J. Klossa and J. Serra. “**Le retour du microscope en hématologie: imagerie numérique et morphologie**” (in French). In *Premier Colloque “Sang et Vin”*, Bordeaux, France, April 2001.
- F. Meyer, M. Coster and J. Angulo. “**Tutorial on Image Analysis and Mathematical Morphology**”. In *7th Congress of the European Society for Analytical Cellular Pathology*, Caen, France, April 2001.
- J. Angulo and J. Serra. “**Etude morphologique de la texture de la chromatine des lymphocytes**” (in French). In *24ème Journée ISS (International Society for Stereology - France)*, Paris, France, February 2001.
- J. Angulo. “**Cytologie quantitative et morphologie mathématique: Application aux syndromes lymphoprolifératifs**” (in French). In *Ecole d’été de Morphologie Mathématique 2000, Centre de Morphologie Mathématique - Ecole des Mines de Paris*, Fontainebleau, France, September 2000.
- J. Klossa, J. Angulo, P. Hauri and G. Migliore. “**Instruments and Telepathology**”. In *5th European Congress on Telepathology*, Aurich, Germany, July 2000.

## REFEREE SERVICE

- Bioinformatics Journal
- IEEE Transactions on Pattern Analysis and Machine Intelligence Journal
- Machine Vision and Applications Journal
- BioTechniques Journal
- 7th International Symposium on Mathematical Morphology (ISMM’05), April 2005, in Paris, France

- Signal Processing in Bio-engineering section of the IEEE 2005 Workshop on Signal Processing Systems (SIPS'05), November 2005, in Athens, Greece
- Fifth IASTED International Conference on Visualization, Imaging, and Image Processing (VIIP 2005), September 2005, in Benidorm, Spain: Member of the International Program Committee
- XII International Computing Conference 2003, Mexico
- International Workshop GEOPRO 2003 (Semantic Processing of Spatial Data), Mexico: Member of the International Program Committee
- International Conference on Cybernetics and Information Technologies, Systems and Applications (CITSA 2004 and 2005), July 2004 and July 2005, in Orlando, Florida, USA

## PROFESSIONAL MEMBERSHIP

- Associate Editor of Book Series “Research on computing science”, Edited by Instituto Politécnico Nacional, Mexico
- Groupe Français de l’Image Numérique Couleur (French Color Imaging Group)

## SUPERVISED STUDENTS

- *Miguel A. Luengo*, Master Thesis (9 months in 2004): “Mathematical morphology in polar-logarithmic coordinates and geometrical methods of classification. Application to study the erythrocytes”.
- *Gauravdeep Singh Sagar*, Internship (Summer 2004): “Development of a GUI to pilot the cDNA microarray image analysis algorithms and research on a new algorithm to detect the skew of images”.



## SUMMARY OF Ph.D. THESIS

### Mathematical morphology and image color indexing. Applications to bio-medical microscopy.

In the field of image processing and analysis for biomedical microscopy color represents an important information source, which combined with the geometry and the morphology of structures allows the development of more robust and more powerful quantitative techniques. This is also the case for multimedia applications, in particular for content-based image retrieval. Nevertheless, the representation and the processing of color image processing remains an open problem.

This thesis intends to explore generic methods for image filtering, segmentation and feature extraction of color images based on mathematical morphology operators. From a more practical point of view, two specific applications are considered; the analysis of cells in quantitative hematology and the automatic reading of DNA microarrays.

We initially deal with the problem of color spaces. Mathematical results justify the use of the 3D-polar coordinate color spaces, type hue/luminance/saturation, for image processing. In addition, we show the practical advantages of such representations when one builds two-dimensional histograms hue/saturation and luminance/saturation in order to segment color image and to extract reflections, trends and shadows from color images.

We can therefore approach the extension of certain morphological operators for the filtering and the segmentation of color or multispectral images. The main aim being the development of color operators, extension of the scalar ones, which are adapted to the advantageous characteristics of color spaces hue/luminance/saturation. The fact of having at our disposal chromatic and achromatic information in an independent way, as well as an additional variable as the saturation (which plays the role of weight of control between the chromatic/achromatic ones), enables us to propose some different ways for filtering and segmenting jointly the chromatic and achromatic structures of a color image. Many examples show the interest of this approach.

We then describe the results of various concrete studies on the characterisation and the classification of shape, texture and color of the objects of an image by means of operators such as the granulometries and the color histograms.

Finally, we tackle two applications in biomedical quantitative microscopy. The first application being an integrated technological platform for segmentation, feature extraction and classification of cells in peripheral blood smears, within the framework of networking applications (telehematology). In the second application we use the most advanced morphological operators in a very powerful automatic approach for the extraction of the spot data of a DNA microarray image.

***Key words:***

color image analysis, mathematical morphology, hue/luminance/saturation color spaces, color filtering, color segmentation, feature extraction, biomedical quantitative microscopy, microarrays, hematological cytology, telepathology