# 14—1 Machine Vision for Medicine of 21st Century

Nicholas Ayache,
Epidaure Project,
Inria
2004 Route des Lucioles,
06902 Sophia-Antipolis, France.
ayache@sophia.inria.fr
http://www-sop.inria.fr/epidaure/

## Abstract

Medical Image Analysis, Surgery Simulation, and Medical Robotics are young scientific fields with huge potential applications and many challenging research problems. I will present a list of such problems including rigid and deformable registration of multimodal brain images, motion analysis from dynamic sequences of cardiac images, and soft-tissue modeling for liver surgery. I will also discuss some recent advances and perspectives, and illustrate my presentation with current projects involving our research group Epidaure at INRIA. Interested readers can find a recent bibliography on the subject in the following surveys [1, 2, 3], in the proceedings of the MICCAI conference [4], or in the recent issues of the *MedIA*, *TMI* or *CAS* journals [5, 6, 7].

## Acknowledgments

The author wants to acknowledge David Rey and the Epidaure group at INRIA for the preparation of this talk, and also Gilles Kahn for his permanent advices and support.

## References

[1] N. Ayache. Medical Image Analysis and Simulation. In *Advances in Computing Science, ASIAN'97*, volume 1345 of *Lec. Notes in Computer Science*, pages 4–17, December 1997. Springer.

[2] N. Ayache. L'analyse Automatique des Images Médicales: Etat de l'Art et Perspectives (In French). *Annales de l'Institut Pasteur*, 9(1):13–21, 1998. Numéro Spécial sur les progrès récents de l'imagerie médicale.

[3] D. Duncan and N. Ayache. Medical Image Analysis: Progress over Two Decades and the Challenges Ahead. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 22(1):85–106, January 2000.

[4] Medical Image Computing and Computer Assisted Intervention Conference. *MICCAI*, http://www.miccai.org/.

[5] Medical Image Analysis Journal, *Oxford University Press*, http://www.oup.co.uk/jnls/list/mediaj/.

[6] Transactions on Medical Imaging, *IEEE*, http://www.ieee.org/organizations/pubs/.

[7] Computer Aided Surgery Journal. *Wiley*, http://jws-edcc.interscience.wiley.com/cas.

[8] D. Rey, G. Subsol, H. Delingette, and N. Ayache. Automatic Detection and Segmentation of Evolving Processes in 3D Medical Images: Application to Multiple Sclerosis. In *Information Processing in Medical Imaging, IPMI'99*, volume 1613 of *Lec. Notes in Computer Science*, pages 154–167, June 1999. Springer. http://www.inria.fr/RRRT/RR-3559.html.

[9] A. Roche, X. Pennec, M. Rudolph, D.P. Auer, G. Malandain, S. Ourselin, L.M. Auer, and N. Ayache. Generalized Correlation Ratio for Rigid Registration of 3D Ultrasound with MR Images. In *Medical Image Computing and Computer Assisted Intervention Conference, MICCAI'00*, October 2000. http://www.inria.fr/RRRT/RR-3980.html

[10] J. Declerck, N. Ayache and E. McVeigh. Use of a 4D Planispheric Transformation for the Tracking and the Analysis of LV Motion with Tagged MR Images. Research report. October 1998. http://www.inria.fr/RRRT/RR-3535.html

[11] G. Picinbono, H. Delingette, and N. Ayache. Real-Time Large Displacement Elasticity for Surgery Simulation: Non-Linear Tensor-Mass Model. In *Medical Image Computing and Computer Assisted Intervention Conference, MICCAI'00*, October 2000.

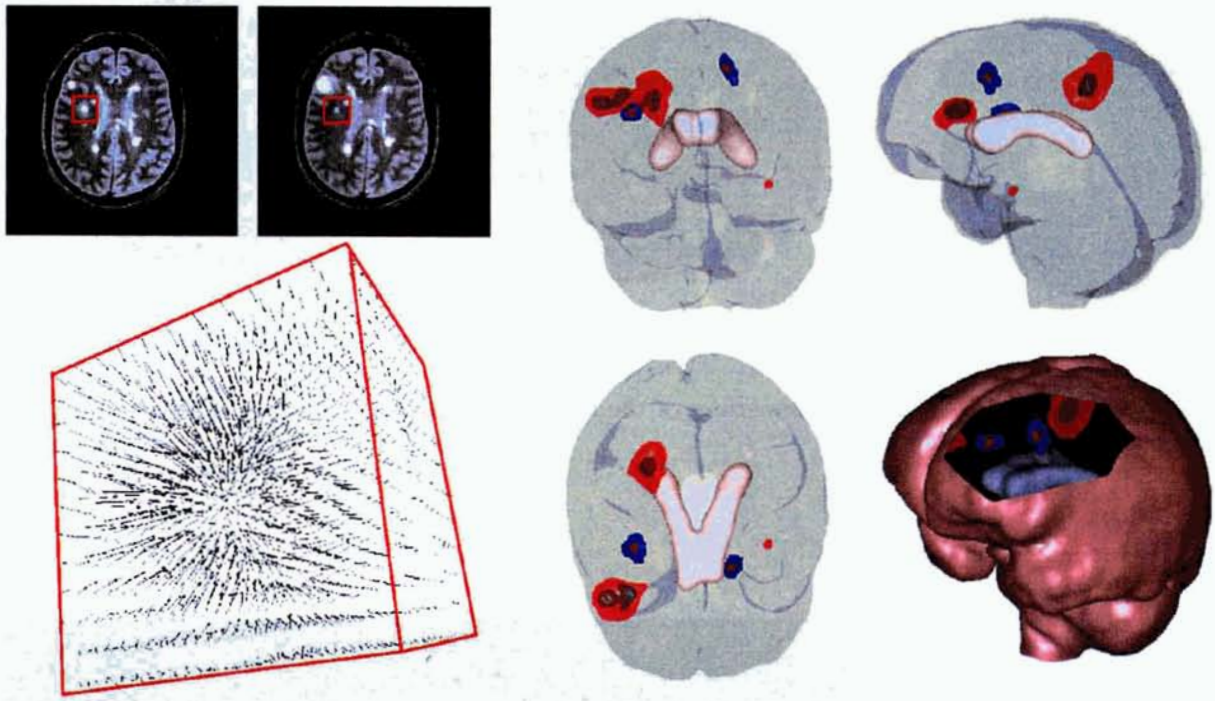

Figure 1: Automatic detection and quantification of evolving lesions from 2 successive Magnetic Resonance Images of a patient with multiple sclerosis (there is an interval of 2 weeks between the 2 images) [8].

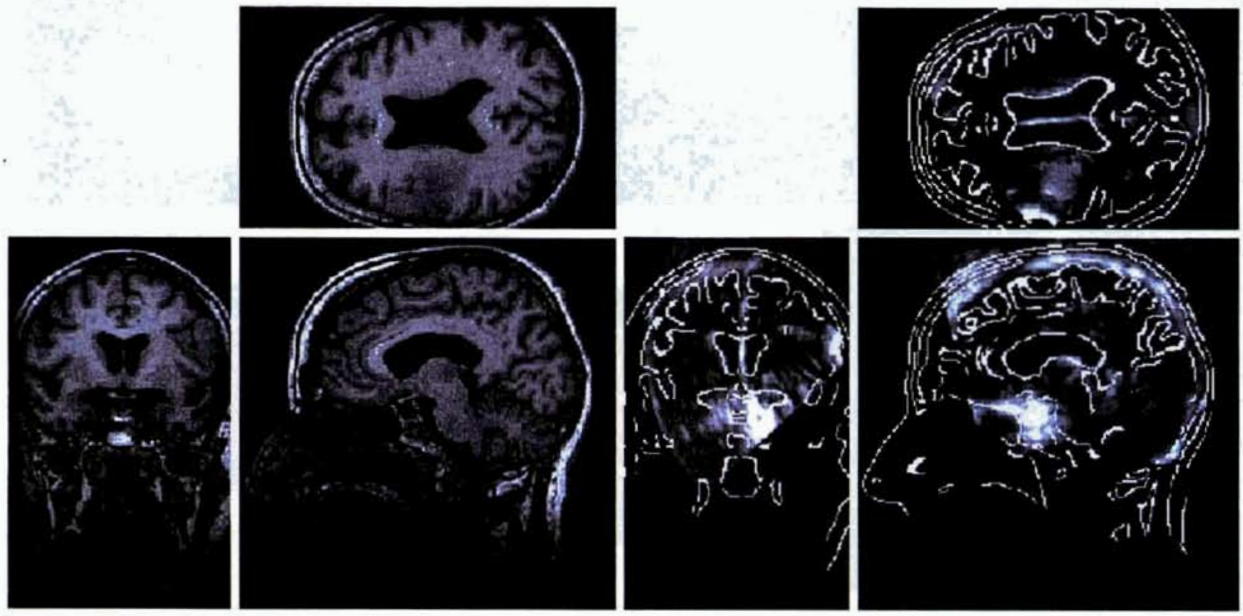

Figure 2: Automatic registration of per-operative 3-D ultrasounds with pre-operative 3-D Magnetic Resonance Image for neuroendoscopic surgery [9].

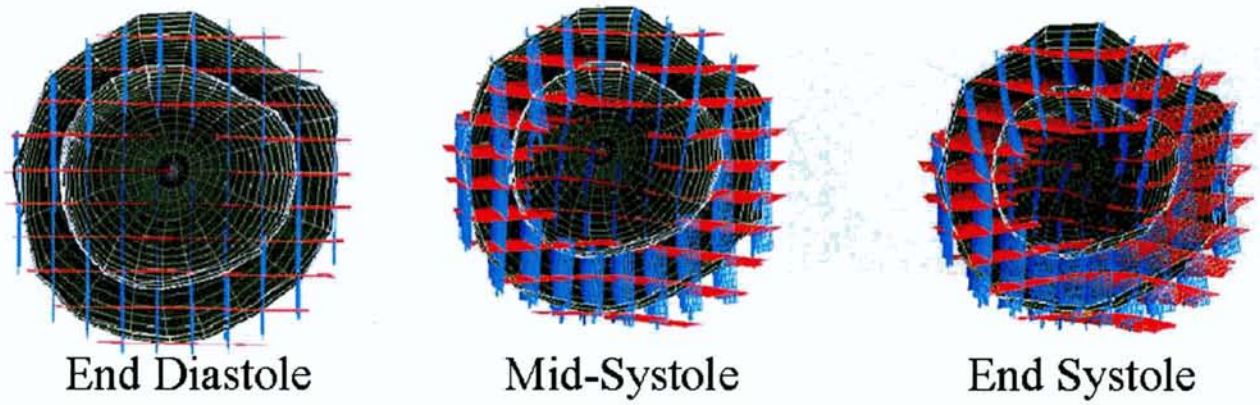


Figure 3: Automatic analysis of the deformations of the left ventricule from a dynamic sequence of tagged magnetic resonance images. [10]

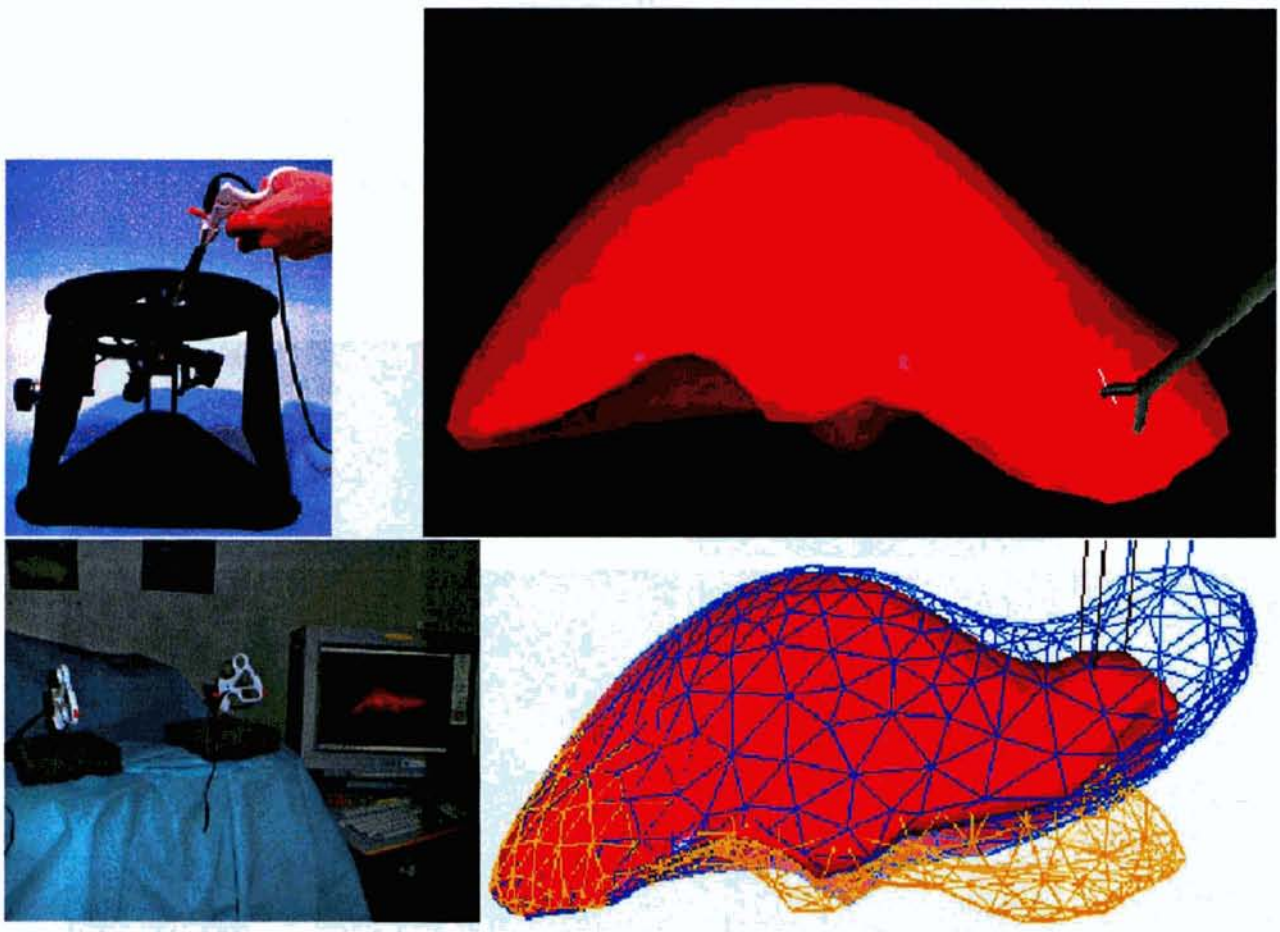

Figure 4: Non linear modelling of liver tissues for simulation of minimally invasive surgery with visual and haptic feedback [11].