Scientific Curriculum Vitæ

Nicolas PRONOST

Teaching Assistant in **Computer Science** in the **Bunraku** Project of the **IRISA** Laboratory (Rennes, France) until August, 1st 2007.

Field of expertise: Computer animation and simulation of human motion
- ▷ Retargeting and motion data sets
- ▷ Motion capture
- ▷ Forward and inverse kinematics
- ▷ Biomechanics and dynamics
- ▷ Physical real-time simulation

Personnal Data

Last Name	PRONOST	Private Address	22 rue Alain Gerbault
First Name	Nicolas		35000 Rennes, France
Birth	May, 7th 1979	Phone number	(+33)06.73.62.48.97
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Nationality	French	Home page	
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Computer Science Skills

Programming languages/environments:
- ▷ C++, C
- ▷ Mathematica, Matlab
- ▷ Java

Standards of human animation field:
- ▷ HAnim, DH notation
- ▷ VRML, inventor
- ▷ Vicon files (C3D), BVH

Development on:
- ▷ Unix / Linux
- ▷ Windows

Documentation utilities:
- ▷ Microsoft Office, OpenOffice
- ▷ LaTeX
- ▷ doxygen

Research Interests (Ph.D. thesis)

My research interests concern the **study of the human** thanks to methods of **analysis** and **synthesis** of its motions. These methods raise crucial problems in many scientific fields such as biomechanics, anthropology or animation. My work proposes a complete process of analysis and synthesis of human locomotions.

This process is composed of the following elements:

- A method of **kinematic adaptation** based on a morphological normalisation of a database of locomotions and on an algorithm of interpolation.
- A **validation process of methods of adaptation** based on the study, by an inverse dynamics solver, of its influence on the physics of the adapted motions.
- A method of **forward dynamics synthesis** of locomotions controlled by normalised torques.

The method of kinematic adaptation is the composition of a method of **retargeting** and an algorithm of **interpolation**. The morphological retargeting allows producing plausible locomotions according to anatomical data such as the lengths of the segments or the degrees of freedom of the articular joints. 123 captured motions are normalised by these data and compose a wide database. The dimensional interpolation chooses and combines several motions from the database according to the most influential locomotor parameters on each anatomical axis: the step size, the feet spacing and the rest posture.

Then, the method computes, from an **inverse kinematic solver**, a locomotion respecting biomechanical constraints such as the joint limits, the rest posture and the minimisation of the rotational energy consumption. As in classical inverse kinematics approaches, the resolution of the primary task ensures that the effector follows the effectors trajectories, the ankles in my work. Finally, I estimate the angular trajectories at the ankles through an algorithm preventing the ground penetration of the feet.
I propose results from **paleoanthropologic data** on the skeleton of the Australopithecus Lucy (A.L. 288-1), thanks to the framework of an ATIP CNRS grant.

From a mechanical description of the character degrees of freedom (based on the robotical modified Denavit-Hartenberg notation) and the adapted motion, I define a mapping algorithm computing the dimensional model (transformation matrix between joints) and the joint-angle motion (usefull in the dynamics laws). Then, I automatically create a biomechanical representation of the virtual human using average anthropometric tables and regression laws. The kinematic representation is thus improved in a biomechanical representation of the character including masses and inertia information. The physical parameters of the virtual human are so adapted to its morphology and its gender.
I compute then, thanks to an inverse dynamics solver that I defined, the **articular torques** necessary to carry out the motion. The resulting torques, and in particular the ground reaction forces, are the dynamic parameters useful to evaluate the correctness of the adaptation method. The main goal of the analysis consists thus in determining resulting forces and torques and comparing them with literature and experimental data from real force plates measurements. I validate results on our adaptation method, separating the **influence on dynamics** coming from the retargeting and from the interpolation.

Finally, I studied the possibility of using these torques and external forces to synthesize locomotions thanks to a **forward dynamics solver**. As I normalised the database from the morphological data, I define a normalisation of torques and forces from the physical characteristics of the simulated virtual human. I use a library of symbolic resolution of mechanical systems (NMECAM) to solve the forward dynamics issue. Inputs are the initial state of the system, external forces (ground reaction forces and gravity), motors torques and the mechanical system. All of these data are outputs of the dynamics analysis method presented above. The interesting idea in this part is the definition of normalised torques and forces. I discuss the validity of using normalised physical parameters in forward dynamics synthesis and the possibilities of applications in computer animation. To determine this validity, I study several methods of motion comparison separating the concept of distance and resemblance, and I apply them on normalised torques and forces from differents analysed motions.

Education and Professionnal Experiences

Until August 2007

Teaching Assistant in Computer Science at University of Rennes 1, France.

2006

Ph.D. in Computer Science at University of Rennes 1, France.
Title: Definition and realisation of computer tools to model and compute motions for virtual humans.
Keywords: Virtual human animation, mechanical and physical simulation, motion capture and adaptation, biomechanics and dynamics

Jury:	Yves Bekkers	Professor, University of Rennes 1, France
	Sylvie Gibet	Professor, University of Bretagne Sud, France
	Yannick Rémion	Professor, IUT of Reims, France
	Qunsheng Peng	Professor, Zhejiang University of Hangzhou, P.R. China
	Bruno Arnaldi	Professor, INSA of Rennes, France
	Georges Dumont	Assistant Professor, ENS Cachan, France

2003

Master in Computer Science from the University of Rennes 1, France.
Master thesis training period at IRISA-INRIA Laboratory.
Title: Proposition of validation tools for walk hypotheses, application to the bipedalism of the Australopithecus Lucy.

▷ Within the framework of an ATIP CNRS grant (from French Minister of Research) : "evaluating locomotor abilities in early hominids: 3D modeling and simulation of Lucy's bipedalism"

▷ Collaborations with laboratories of biomechanics (LPBEM, Rennes, France) and paleoanthropology (CNRS UPR 2147, Paris, France)

2002

University Degree of "Maîtrise" (degree obtained after four years at the University) in Computer Science from the University of Rennes 1, France.
Thesis training period: Simulation of cooperative robots in a virtual environment.

▷ oRis (agent) programming, real-time simulation and reactive system conception.

2001

Bachelor's degree (degree obtained after three years at the University) in Computer Science from the University of Rennes 1, France.

1998

Baccalaureat (High school degree), mathematics speciality, from Lycée Victor Hugo, Hennebont, France.

Publications

International Journal Papers

Nicolas Pronost and Georges Dumont. Dynamics-based analysis and synthesis of human locomotion. In *The Visual Computer*, Summer 2007.

Nicolas Pronost, Georges Dumont, Gilles Berillon and Guillaume Nicolas. Morphological and stance interpolations in database for simulating bipedalism of virtual humans. In *The Visual Computer* (22-1), pages: 4-13, January 2006.

International Conference Papers

Nicolas Pronost and Georges Dumont. Validating retargeted and interpolated locomotions by dynamics-based analysis. In *Proceedings of International Conference on Computer Graphics and Interactive Techniques (GRAPHITE) 2006*, Kuala Lumpur, Malaysia, pages: 65-74, 29 November - 2 December 2006.

Nicolas Pronost, Guillaume Nicolas, Georges Dumont and Franck Multon. Combining morphological interpolation and biomechanical inverse kinematics to simulate bipedal locomotion. In *Proceedings of IASTED Visualization, Imaging and Image Processing 2005 Conference*, Benidorm Spain, pages: 39-45, 7-9 September 2005.

National Journal Papers

Nicolas Pronost and Georges Dumont. Influences des adaptations morphologiques et cinématiques sur la dynamique des mouvements. In *Revue Electronique Francophone d'Informatique Graphique REFIG* (1-1), pages: 45-52, March 2007.

National Conference Papers

Nicolas Pronost, Franck Multon, Qilei Li, Weidong Geng, Richard Kulpa and Georges Dumont. Techniques d'animation pour gérer les interactions entre combattant virtuel et sujet réel. To appear in *2èmes Journées de l'AFRV*, Marseille, France, 25-26 October 2007.

Nicolas Pronost and Georges Dumont. Influences des adaptations morphologiques et cinématiques sur la dynamique des mouvements. In *19èmes Journées de l'AFIG*, Bordeaux, France, 22-24 November 2006.

Nicolas Pronost and Georges Dumont. Validation de mouvements adaptés par analyse de la dynamique et squelette biomécanique. In *Proceedings of 13èmes Journées du GTAS*, Toulouse, France, 15-16 June 2006.

Nicolas Pronost, Guillaume Nicolas, Georges Dumont, Franck Multon and Gilles Berillon. Simulation d'une locomotion bipède par adaptation de mouvement et cinématique inverse. In *Proceedings of 11èmes Journées du GTAS*, Reims, France, 17-18 June 2004.

Nicolas Pronost. Modélisation et calcul de mouvement pour l'humanoïde virtuel - Une application paléoanthropologique. *20ème Congrès Industriel de Belfort*, Belfort-Montbéliard, France, 23-24 March 2004.

Nicolas Pronost. Interpolation morphologique et posturale pour la simulation de mouvement d'un humanoïde virtuel. *11èmes Journées des utilisateurs Vicon*, Rennes, France, 19 March 2004.

Nicolas Pronost, Georges Dumont and Gilles Berillon. Interpolation morphologique et posturale pour la simulation de mouvement d'un humanoïde virtuel. In *Proceedings of 16èmes Journées de l'AFIG*, Paris, France, pages 121-128, December 2003.

Thesis

Nicolas Pronost. Définition et réalisation d'outils de modélisation et de calcul de mouvement pour des humanoïdes virtuels. Ph.D. thesis, University of Rennes 1, December 2006.