Natural Sciences and Engineering Research Council of Canada | Conseil de recherches en sciences naturelles et en génie du Canada

Date 2009/07/25

Notification of Intent to Apply for a Discovery Grant

Avis d'intention de présenter une demande de subvention à la découverte

APPLICANT / CANDIDAT

Family name / Nom de famille	Given name / Prénom	Initial(s) of all given names / Initiale(s) de tous les prénoms	Personal identification no. (PIN) / N° d'identification personnel (NIP)
van de Panne	Michiel	.	**Valid/Valide** 103212

Department (at the time of application) / Département (au moment de présenter votre demande)	Institution (where you will hold your grant) / Établissement (où vous détiendrez la subvention)
Computer Science	University of British Columbia

E-mail address / Adresse de courriel: van@cs.ubc.ca

Degrees / Diplômes	Discipline / Discipline	University / Établissement	Supervisor / Directeur de travaux	Year / Année
Master's / Maîtrise	Electrical Engineering	University of Toronto	Eugene Fiume and Zvonko Vranesic	1989
Doctorate / Doctorat	Electrical and Computer Engineering	University of Toronto		1994
Postdoctoral experience / Expérience postdoctorale				

EVALUATION GROUP ASSIGNMENT / ASSIGNATION DU GROUPE D'ÉVALUATION

Suggest the number of the evaluation group you feel should review your application. / Entrez le numéro du groupe d'évaluation qui selon vous devrait évaluer votre demande. 1507

NOTE / Remarque : NSERC makes the final evaluation group assignment. L'assignation finale à un groupe d'évaluation revient au CRSNG.

APPLICATION INFORMATION / RENSEIGNEMENTS SUR LA DEMANDE

Title of proposal / Titre de la proposition

Scalable Physics-based Modeling of Skilled Movement

TYPE OF APPLICATION / TYPE DE DEMANDE

- Individual / Individuelle: X
- Team / Équipe:
- Project (for Subatomic Physics only) / Projet (pour physique subatomique seulement):

Research topic(s) that describe the proposed research / Sujets de recherche décrivant la recherche proposée

CS19, CS21

The application will be submitted in / La demande sera présentée en

X English / anglais ☐ français / French

KEY WORDS that best describe the proposed research / MOTS CLÉS qui décrivent le mieux la recherche proposée

character animation, computer graphics, physics-based simulation, motor control, humanoid robotics, motion planning

Personal Information Bank Number: SER/P-PU-095.
For information on the *Privacy Act*, consult the current NSERC *Program Guide for Professors.*

N° du fichier de renseignements personnels : RSG/P-PU-095.
Pour obtenir de l'information sur la Loi sur la protection des renseignements personnels, consultez le plus récent *Guide des programmes destiné aux professeurs* du CRSNG.

Canada

van de Panne, . (Michiel)

SUMMARY OF PROPOSAL / RÉSUMÉ DE LA PROPOSITION

In the space provided below, state the objectives of the proposed research program and summarize the scientific approach, highlighting the novelty and expected significance of the work to a field or fields in the natural sciences and engineering. Note that NSERC supports research in the natural sciences and engineering (other than the health sciences).

Dans l'espace prévu ci-dessous, énoncez les objectifs du programme de recherche proposé et résumez la démarche scientifique, en soulignant l'originalité et l'importance prévue des travaux dans un ou plusieurs domaines des sciences naturelles ou du génie. Veuillez noter que le CRSNG appuie la recherche dans le domaine des sciences naturelles et du génie, à l'exception des sciences de la santé.

Humans and animals move through their world and interact with their environment in robust, graceful, and highly skilled ways. We do not yet know how to design realistic animated characters, biomechanical human simulations, and robots that can mimic this degree of skill. Significant progress has been made in developing data-driven kinematic models of motion, as well as physics-based simulations of motion. Models for the latter require the development of motor control strategies to drive the movement, and this has long been a vexing problem. However, a number of recent developments suggest that we are at the cusp of seeing dramatic advances in the capabilities of physics-based models of skilled motion. We propose a number of number of specific objectives and approaches to achieve these objectives that will contribute towards realizing this next generation of models.

Developing locomotion controllers has been a significant and successful focus for physics-based character animation, robots, and biomechanical models of humans and animals. We wish to find ways of taking the lessons learned and scaling them in many ways. How can we make the development of shareable, composable controllers a collaborative task, driven by a large community of users? How can we develop controllers capable of exaggerated comic-book motions for animation while still working within a physics-based framework? To what extent can we develop motion control strategies that work with `sensory soup' instead of compact state descriptions? How do we develop controllers for a much wider range of motions, including the natural weight-shifting and foot movements that occur during standing conversations, fully general walking over arbitrary terrain, and climbing motions? more. How can low-level skills be integrated into skilled task-level behavior? Can we go beyond motion capture and capture more abstract features of motions and their context in order to do data-driven 'behavior capture'? Can we develop optimizations and hybrid kinematic/dynamic methods that allow for the simultaneous simulation of tens or hundreds of physics-based characters? How can motion controllers be efficiently parameterised with respect to body dimensions? Can existing control strategies be successfully transferred from simulations to actual robots or real-or-simulated biomechanical systems?

To make progress on at least a subset of the above questions, we intend to build on a variety of recent work, including our own. We make an explicit choice to work heavily with synthesis and optimization, i.e., embodied models of motion, coupled with the lightweight use of motion capture data as a 'natural human movement' reference for both motions and higher-level behaviors. Specific methods and tools of our approach include: the use of large-scale motion optimization and continuation methods; defining a language and development environment for community-based controller authoring; exploring the use of sub-goals and multi-level abstractions in tackling motion planning and control at multiple temporal scales; and the use of apprenticeship learning to establish reward or cost functions that are appropriate for a given task. For experimentation with real dynamical systems, we expect to pursue the purchase of a humanoid robot or, alternatively, to develop close collaborations with groups with significant humanoid robot experience.

As models of motion for physics-based character animation, robotics, biomechanical human motion, and animal motion become increasingly sophisticated, a significant degree of convergence is likely. We believe that physics-based animation has a good possibility of playing a leading role in this convergence for several reasons, including the relative ease of experimentation in physics-based simulations, the lack of physical device limitations, the accessibility of motion capture data, and the familiarity with modern machine learning methods. The proposed research thus has the potential to have a broad impact, as issues related to optimization, learning, and new representations for control strategies move to center-stage in the modeling and control of skillful motion.

van de Panne, . (Michiel)

Before completing the following section, refer to the instructions.

Referees **should be** capable of reviewing your application in the language in which it is written.

Avant de remplir la section suivante, consultez les instructions.

Les examinateurs **devraient pouvoir** étudier votre demande dans la langue de présentation.

REFEREE SUGGESTIONS / EXAMINATEURS SUGGÉRÉS

BY THE APPLICANT PAR LE CANDIDAT	Area(s) of expertise Domaine(s) d'expertise	BY THE EVALUATION GROUP PAR LE GROUPE D'ÉVALUATION
A Hodgins, K. (Jessica) Computer Science and Robotics Carnegie Mellon University 5000 Forbes Ave Pittsburgh, PA, UNITED STATES 15213 jkh@cs.cmu.edu (412) 268-6436	computer animation, humanoid robotics	**1** PIN / NIP: Lang.
B Fiume, L. (Eugene) Computer Science University of Toronto 40 St. George Street Toronto, ON, CANADA M5S2E4 elf@dgp.toronto.edu (416) 978-5472	computer graphics, computer animation	**2** PIN / NIP: Lang.
C Wyvill (Brian) Computer Science University of Victoria PO Box 3055, STN CSC Victoria, BC, CANADA V8W3P6 blob@cs.uvic.ca (250) 472-5760	computer graphics	**3** PIN / NIP: Lang.
D Ruina (Andy) Theoretical and Applied Mechanics Cornell University 306 Kimball Hall Ithaca, NY, UNITED STATES 14853 ruina@cornell.edu (607) 255-7108	mechanics of locomotion, robotics	**4** PIN / NIP: Lang.
E Badler, I. (Norman) Computer and Information Science University of Pennsylvania 3330 Walnut Street Philadelphia, PA, UNITED STATES 19104 badler@seas.upenn.edu (215) 898-5862	computer animation	**5** PIN / NIP: Lang.

EG / GE	1st Reviewer / 1er évaluateur	PIN / NIP
	2nd Reviewer / 2e évaluateur	PIN / NIP

1 Research Contributions, 2003–2009

1.1 Journals

[J8] **Hamish Carr**, Jack Snoeyink, and Michiel van de Panne. Flexible isosurfaces: Simplifying and displaying scalar topology using the contour tree. *Computational Geometry: Theory and Applications*, 2009. in press.

[J7] Weiwei Xu, Jun Wang, KangKang Yin, Kun Zhou, Michiel van de Panne, Falai Chen, and Baining Guo. Joint-aware manipulation of deformable models. *ACM Trans. Graphics (Proc. ACM SIGGRAPH)*, 28(3), 2009. 9 pages.

[J6] **KangKang Yin**, **Stelian Coros**, **Philippe Beaudoin**, and Michiel van de Panne. Continuation methods for adapting simulated skills. *ACM Trans. Graphics (Proc. ACM SIGGRAPH)*, 27(3), 2008. 7 pages.

[J5] **Stelian Coros**, **Philippe Beaudoin**, **KangKang Yin**, and Michiel van de Panne. Synthesis of constrained walking skills. *ACM Trans. Graphics (Proc. ACM SIGGRAPH ASIA)*, 27(5), 2008. 9 pages.

[J4] Tao Ju, Qian-Yi Zhou, Michiel van de Panne, Danny Cohen-Or, and Ulrich Neumann. Reusable skinning templates using cage-based deformations. *ACM Trans. Graphics (Proc. ACM SIGGRAPH ASIA)*, 27(5), 2008. 10 pages.

[J3] **KangKang Yin**, **Kevin Loken**, and Michiel van de Panne. SIMBICON: Simple biped locomotion control. *ACM Transactions on Graphics (Proc. SIGGRAPH)*, 26(3), 2007. 10 pages.

[J2] **Jason Harrison**, Ron Rensink, and Michiel van de Panne. Obscuring length changes during animated motion. *ACM Transactions on Graphics (Proc. SIGGRAPH)*, 23(3):569 – 573, 2004.

[J1] **Matthew Thorne**, **David Burke**, and Michiel van de Panne. Motion Doodles: An interface for sketching character motion. *ACM Transactions on Graphics (Proc. SIGGRAPH)*, 23(3):424 – 431, 2004.

1.2 Conference and Workshop Proceedings, refereed on full paper

[C16] Nicolas Bonneel, Sylvain Paris, Michiel van de Panne, Frdo Durand, and George Drettakis. Single photo estimation of hair appearance. In *Eurographics Symposium on Rendering*, 2009.

[C15] Vladislav Kraevoy, Alla Sheffer, and Michiel van de Panne. Modeling from contour drawings. In *Proc. Sketch-Based Interfaces and Modeling*, 2009.

[C14] Philippe Beaudoin, Michiel van de Panne, Pierre Poulin, and **Stelian Coros**. Motion-motif graphs. In *ACM/EG Symposium on Computer Animation*, 2008. 10 pages.

[C13] Philippe Beaudoin, Pierre Poulin, and Michiel van de Panne. Adapting wavelet compression to human motion capture clips. In *Proceedings of Graphics Interface*, 2007. 6 pages.

[C12] **Maciej Kalisiak** and Michiel van de Panne. Faster motion planning using learned local viability models. In *Proceedings of IEEE International Conference on Robotics and Automation*, 2007. 6 pages.

[C11] **Dana Sharon** and Michiel van de Panne. Constellation models for sketch recognition. In *SBIM'06: Eurographics Workshop on Sketch Based Interfaces and Modeling*, pages 19–27, 2006. Selected as one of best papers for forwarding to *Computers and Graphics* journal; have not acted on this yet.

[C10] **Zhijin Wang** and Michiel van de Panne. Walk to here: A voice driven animation system. In *ACM SIGGRAPH / EG Symposium on Computer Animation (SCA)*, pages 243–251, 2006.

[C9] **Maciej Kalisiak** and Michiel van de Panne. RRT-blossom: RRT with a local flood-fill behavior. In *Proceedings of IEEE International Conference on Robotics and Automation*, 2006. 6 pages.

[C8] **Kangkang Yin**, Dinesh Pai, and Michiel van de Panne. Data-driven interactive balancing behaviors. In *Pacific Graphics*, 2005. Accepted as 4-page short paper; full paper is 9 pages.

[C7] **Chen Yang**, **Dana Sharon**, and Michiel van de Panne. Sketch-based modeling of parameterized objects. In *Eurographics Workshop on Sketch-Based Interfaces and Modeling*, 2005. 10 pages.

[C6] **Dana Sharon** and Michiel van de Panne. Synthesis of controllers for stylized planar bipedal walking. In *IEEE International Conference on Robotics and Automation*, 2005. 6 pages.

[C5] **Ken Alton** and Michiel van de Panne. Learning to steer on winding tracks using semi-parametric control policies. In *IEEE International Conference on Robotics and Automation*, 2005. 6 pages.

[C4] **Peng Zhao** and Michiel van de Panne. User interfaces for interactive control of physics-based 3d characters. In *ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, 2005. 8 pages.

[C3] **Hamish Carr**, Jack Snoeyink, and Michiel van de Panne. Simplifying flexible isosurfaces using local geometric measures. In *Proceedings of IEEE Visualization*, 2004. 8 pages.

[C2] **Maciej Kalisiak** and Michiel van de Panne. Approximate safety enforcement using computed viability envelopes. In *Proceedings of IEEE International Conference on Robotics and Automation*, 2004. 6 pages.

[C1] **Petros Faloutsos**, Michiel van de Panne, and Demetri Terzopoulos. Autonomous reactive control for simulated humanoids. In *IEEE International Conference on Robotics and Automation*, 2003. 8 pages.

1.3 Other: Reviewed on abstract, posters, sketches

[AP9] **Stelian Coros**, **Philippe Beaudoin**, and Michiel van de Panne. Towards games with physics-based characters. In *ACM/EG Symposium on Computer Animation*, 2009. poster presentation.

[AP8] **Stelian Coros**, **Philippe Beaudoin**, and Michiel van de Panne. Control of a physics-based character in a virtual environment. In *Dynamic Walking*, 2009. poster presentation.

[AP7] **Stelian Coros**, **Philippe Beaudoin**, **KangKang Yin**, and Michiel van de Panne. Synthesis of constrained walking skills. In *ACM/EG Symposium on Computer Animation*, 2008. poster presentation.

[AP6] **Stelian Coros**, **KangKang Yin**, **Kevin Loken**, and Michiel van de Panne. SIMBICON: simple biped locomotion control. In *Dynamic Walking*, 2007. poster presentation.

[AP5] David White, **Kevin Loken**, and Michiel van de Panne. Slow-in and slow-out cartoon animation filter. In *Poster presentation, ACM SIGGRAPH*, 2006. finalist in best-poster competition (top 25/179).

[AP4] **Chen Yang**, **Dana Sharon**, and Michiel van de Panne. Sketch-based modeling of parameterized objects. In *ACM SIGGRAPH Technical Sketch*, 2005.

[AP3] **Jason Harrison**, Ron Rensink, and Michiel van de Panne. Length changes are difficult but not impossible to detect without attention. Vision Sciences Society, 2004. refereed abstract and poster presentation.

[AP2] **Jason Harrison**, Ron Rensink, and Michiel van de Panne. Detecting changes of velocity of smoothly moving objects. Vision Sciences Society, May 9-14 2003. refereed abstract and poster presentation.

[AP1] **Hamish Carr**, Jack Snoeyink, and Michiel van de Panne. Contour tree simplification with local geometric measures. In *14th Annual Fall Workshop on Computational Geometry*, 2004. Reviewed by abstract only.

2 BOOKS

2.1 Edited

[B2] Michiel van de Panne and Eric Saund, editors. *Proceedings of Sketch Based Interfaces and Modeling*. ACM SIGGRAPH and Eurographics, 2008. ISBN:978-1-59593-915-3.

[B1] Kori Inkpen and Michiel van de Panne, editors. *Proceedings of Graphics Interface*. AK Peters Ltd., 2005. ISBN 1-56881-265-5.