Aalto University

Dissertation press release 15.05.2020

Simulating human climbing to advance embodied artificial intelligence

Title of the dissertation	Discovering, Synthesizing, and Learning Climbing Movements
Contents of the dissertation	The dissertation investigates path planning, sampling-based optimization, and machine learning methods for synthesizing human wall climbing movements. The approaches developed in the dissertation can plan and control the movements of a biomechanically simulated human character so that it reaches a given target climbing hold from user-defined start holds. The technology has potential applications in robotics, computer animation, and computer games. Simulated climbing is a challenging problem for AI, as it requires both long-horizon planning of movement strategies and sequences, and precise motor control of individual movements. First, the dissertation proposes a hierarchical method that combines graph search and sampling-based optimization, resulting in the first system that is able to simulate complex climbing movements with multiple simultaneously moving limbs, with no reference movement data. This approach is then enhanced using machine learning methods, both in a supervised and reinforcement learning manner. Supervised learning on previously simulated movements is demonstrated to allow more agile movements with less failures. Reinforcement learning allows movements to be synthesized in real-time. Throughout the course of the dissertation, the developed methods evolve to allow higher movement quality and/or lower computation time. A particular strength of the work is that no reference movement data – e.g., motion capture – is needed. The movements and strategies are improvised and discovered through simulated experimentation, first randomly, and then exploring variations of the most effective movements.
Field of the dissertation	Computer Science
Doctoral candidate	Kourosh Naderi, M.Sc. Born in Tehran, Iran, 1989
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Opponent	Professor Steven Lavalle, University of Oulu, Finland
Custos	Professor Perttu Hämäläinen., Aalto University, School of Science, Department of Computer Science
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