Human Movement Adaptation Using a Novel Distance-Based Approach

MimeTIC internship

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Context and Objectives

Human-like characters are typically represented by hierarchical skeletal structures, which basically consist of sets of segments connected by joints. Motions of these characters are then defined as series of local joint rotations (angular space) over time, for all the joints of the character. In some approaches, positions of the joints (Cartesian space) can also be used to drive the performance, for instance when specifying the position of the hand of a virtual character to grasp a virtual object using inverse kinematics [2,3,4]. While these approaches are commonly used to create, adapt, or modify virtual human motions, controlling the motion performance in angular or Cartesian spaces is not straightforward, in particular because of the difficulty of representing relations between body segments. Very recently, we started to investigate the use of distance-based models for the representation of human movements [1], that can be useful for performing efficient movement adaptations.

In this internship, we propose therefore to explore new methods to synthesize human motions based on distances using approaches from the Distance Geometry (DG) community [5,6]. Motion distance information can be represented using a simple weighted undirected graph between joints or points on the surface of the skin. Finding a realization for such a graph in the Euclidean three-dimensional space, so that a given set of distance constraints is satisfied, is a problem known in the scientific literature as the DG problem (DGP). In this internship, we will focus on the adaptation of captured human motions in order to produce novel motions satisfying a certain number of geometrical constraints. The motivation to explore such distance-based approaches comes from the fact that most of those constraints can be easily expressed in terms of distances, e.g., to prevent foot penetration with the ground, to adapt the motion to a new morphology, or to establish a relationship between body parts of a character or between a character and the environment. These examples represent the application of DG approaches to solve two types of well-known problems in computer graphics named, respectively, motion retargeting and motion editing.

The main expected result for this internship is a mathematical software for distance-based human motion adaptation. Such a result can have a strong impact on the character animation industry, both for interactive (i.e., games) and non interactive (i.e., cinema) domains.

Environment

The candidate will hosted in the joined Inria / IRISA research centre located in Rennes. Inria (www.inria.fr) and IRISA (http://www.irisa.fr/) are amongst the leading research centres in Computer Sciences in France. The work will be supervised by members of the MimeTIC team, internationally recognised in the fields of Operational Research, Computer Graphics and Virtual Human Simulation.

Requirements for candidacy

- Strong C/C++ programming skills
- Solid background in mathematics

References

1. A. Bernardin, L. Hoyet, A. Mucherino, D.S. Gonçalves, F. Multon, Normalized Euclidean Distance Matrices for Human Motion Retargeting, ACM Conference Proceedings, Motion in Games 2017 (MIG17), Barcelona, Spain, 6 pages, 2017.
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3. E. Ho, T. Komura, and C.-L. Tai. 2010. Spatial relationship preserving character motion adaptation. ACM Trans. Graph. 29, 4
4. R. Kulpa, F. Multon, and B. Arnaldi. Morphology-independent representation of motions for interactive human-like animation. European Association for Computer Graphics. Eurographics, 2005.
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6. A. Mucherino, C. Lavor, L. Liberti, N. Maculan (Eds.). 2013. Distance Geometry: Theory, Methods and Applications, Springer, 410 pages, 2013.