Data-driven Texturing of Human Motions

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Abstract

Creating natural looking human animations is a challenging and time-consuming task, even for skilled animators. As manually generating such motions is very costly, tools for accelerating this process are highly desirable, in particular for pre-visualization or animation involving many characters. In this work a novel method for fully automated data-driven texturing of motion data is presented. Based on a database containing a large unorganized collection of motions samples (mocap database) we are able to either: transform a given "raw" motion according to the characteristic features of the motion clips included in the database (style transfer) or even complete partial animation, e.g. by adding the motion of the upper body if only legs have been previously animated (motion completion). By choosing an appropriate database different artistic goals can be achieved such as making a motion more natural or stylized. In contrast to existing approaches like the seminal work by Pullen and Bregler [2002] our method is capable of dealing with arbitrary motion clips without manual steps, i.e. steps involving annotation, segmentation or classification. As indicated by the examples, our technique is able to synthesize smooth transitions between different motion classes if a large mocap database is available. The results are plausible even in case of a very coarse input animation missing root translation.

1 Overview

The basic idea of our method is to take advantage of motion samples from large databases to improve a given motion. To this end, for each frame pose of the input motion, matching motion segments of a few frames in length are retrieved from the mocap database. For efficient retrieval a technique called Online Lazy Neighborhood Graph (OLNG) is employed [Tautges et al. 2011]. In essence this method is able to identify global temporal similarities based on local neighborhoods in pose space. In a second step, using multi grid optimization techniques, a new motion is synthesized based on the input and the prior information from the database. For our implementation a skeleton-based pose representation with joints and bones is assumed. However, since the method is directly applicable to other motion data (i.e. positional marker data) this constitutes no general limitation of our approach. In the following the individual steps of our pipeline will be discussed in more detail.

Preprocessing. In a preprocessing step all mocap data from the prior-database is first normalized with respect to global position and orientation [Krüger et al. 2010]. Based on normalized positional data of all available joints we then build an efficient spatial indexing structure (kd-tree) that is required for OLNG. In addition, linear marker velocities as well as accelerations are stored. These quantities are needed for subsequent prior-based motion synthesis.

Motion synthesis. We use an energy minimization formulation which is frequently used in data driven computer animation. Our specific choice of the energy terms to be minimized most closely resembles the one used in [Tautges et al. 2011]. Here, the objective function is consisting of three different terms: a control term E_{control} that measures the distance of synthesized and given joint positions included in the feature set, as well as pose E_{pose} and motion priors E_{smooth} and E_{motion} enforcing positions, acceleration and velocities of joints to be comparable to examples retrieved from the database. The objective function is minimized using gradient descent. In addition, to avoid skating artifacts, footprint constraints were forced by an inverse kinematics approach.

To improve the robustness of our method and to speed up the process of optimization, we employ a multi-scale approach.

2 Results

To test the effectiveness of our approach we made several tests for three different scenarios that might occur in practice:

Motion completion: For a given motion missing joints are synthesized. In our case an animation of the lower body was used as input to our method, and a plausible upper body motion was created.

Motion texturing: In this case a rough low quality motion (e.g. from interpolating few key frames) is transformed to a detailed full body animation. We transform a rough walking and jumping jack motion with stiff limbs and no root movement to a realistic full body animation.

Style transfer: Here, characteristic features of one individual are transferred to another within the same motion class. More precisely, we took a complex walking sequence and adopted this motion to match the style of a different subject. This was achieved by using a database containing only motion samples from the respective subject.

3 Conclusion and Future Work

In this work a general frame-work for automated data-driven motion texturing, completion and style transfer for human motions was sketched. Our approach works reasonably well across different motion classes that previously could only be handled with massive user interaction.

We need a mocap-database containing motions which are suitable for processing a given clip according to our method. Thus, the results strongly depend on the prior information stored in the database. Investigating, the impact of using different databases is of fundamental importance and requires more work.

References

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