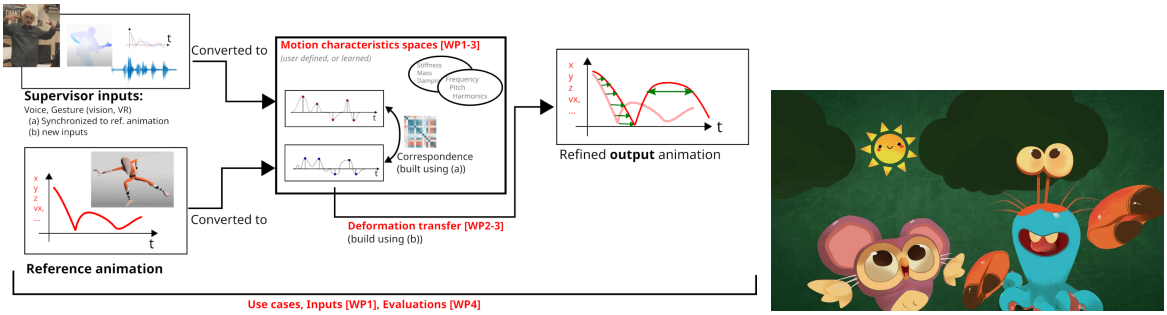
Master Internship in Computer Graphics / Animation

Hierarchical Deformation of Shape Primitives for Expressive Video-based Control on 3D Keyframed Animation



Expressing a modification of a virtual character via gesture and sound. Right: Example of character produced by Dada Animation

Place : LIX, Campus de l'Ecole Polytechnique, Palaiseau

Employer : Ecole Polytechnique (*Taking place at LIX – Laboratoire d'Informatique de l'Ecole Polytechnique)*

Internship Duration: March - September 2024

URL: https://www.lix.polytechnique.fr/vista/job/index.html

Supervisors:

- Damien Rohmer (damien.rohmer@polytechnique.edu)
- Pascal Guehl (pascal.guehl@polytechnique.edu)

Work in partenariat with the Animation Studio: ***Dada ! Animation in Paris*** *- www.dada-animation.com*

Context of the Project:

Creating and tuning 3D animation composed of virtual characters and/or animated elements is a major task of production studios. 3D animators typically use standard tools such as Maya or Blender to specify the so-called *animation curves*. These curves are built by interpolating positional and orientation coordinates of shape controllers called "rig" (e.g. joints of an animation skeleton), and passing through specific values called key-frames.

Once an animation is created, a process of review is performed by the artist itself or its supervisor, to improve iteratively this animation. This review is often performed with our human expressivity, namely our gestures and voices, that needs to be interpreted by the animator as modifications to be applied to the animation curves. This manual edition of these curves allows very precise modifications but remains time-consuming, therefore not allowing fast interactive iterations.

The ANR project AnimationConductor, in which this internship takes place, aims at creating new methodologies and tools to ease the semi-automatic edition and interaction of these animation curves via expressive human inputs such as acquired gestures (video & VR handles), and recorded vocal sounds able to

naturally convey a high-level notion of timing, frequency and magnitude. This project is a collaboration between the two research teams VISTA at LIX/Ecole Polytechnique and VIRTUS IRISA/Univ. Rennes/Inria, and the Animation Studio: Dada! Animation.

Different approaches have been proposed in research to synthesize animation from human inputs, starting from classical Motion Capture (MOCAP) providing a 1-to-1 mapping between the sensor and the character joint, using more general gestures mapping [Arora19, Garcia19], or via drawn sketches [Gay15, Ciccone17, Dvoroznak20]. These works, however focused on synthesizing from scratch a motion that matches as best as possible a given trajectory, but did not rely on an existing motion in order to suggest an appropriate space-time deformation. A few inspirational works attempt to have more general mappings between the human body and a character [Dontcheva03, Fender15], but they focused mostly on character posing rather than on animation authoring. Beyond gestures, sound inputs have also been studied in relation to character animation via natural language for lip synchronization [Zhou18], or to music for dancing characters [Kim03, Li21].

Internship Objective and Proposed Methodology:

Within this internship taking place at LIX, we propose the study of the fundamental mode of deformation of basic shape primitives, namely spheres, cylinders, and sets of point-wise elements. These primitives are often taken as fundamental structures on which animators are representing the salient part of the expressive animation. For instance, squash and stretch deformation are illustrated via sphere-like shapes, bending on cylindrical ones, and point-based particles are used to express the notion of noise and distribution. Every complex rigged character can be seen as a hierarchical assembly of such fundamental primitives seen as proxies around the detailed geometry.

The scientific objective of this internship is to provide a comprehensive study of the degrees of freedom of the deformation to be applied to these three fundamental primitives. These degrees of freedom then need to be related to possible ways to possibly control them via gestures that can be recorded on video and/or onomatopeic sounds. Once defined, we will study the hierarchical organization of a complex shape made with an assembly of such primitive, and express the coupling of deformation between sibling elements in the hierarchy.

A proof of concept may be targeted with the control of a simple primitive or a hierarchical one using simple gestures in front a of webcam system while relying on standard feature extraction such as optical flow.

References

[**Arora19**] R. Arora, R. Habib Kazi, D. Kaufman, W. Li, K. Singh. MagicalHands: Mid-Air Hand Gestures for Animating in VR. UIST 2019.

[**Ciccone17**] L. Ciccone, M. Guay, M. Nitti, R. Sumner. Authoring Motion Cycles. SCA 2017.

[**Dong21**] R. Dong, Y. Lin, Q. Chang, J. Zhong, D. Chai, S. Ikuno. Motion Feature Extraction and Stylization for Character Animation using Hilbert-Huang Transform. ACM ICEA, 2021.

[**Dontcheva03**] M. Dontcheva, G. Yngve, Z. Popovic. Layered Acting For Character Animation. ACM SIGGRAPH 2003.

[**Dvoroznak20**] M. Dvoroznak, D. Sykora, C. Curtis, B. Curless, O. Sorkine-Hornung, D. Salesin. Monster Mash: A Single-View Approach to Casual 3D Modeling and Animation. SIGGRAPH Asia 2020.

[**Fender15**] J. Chen, S. Izadi, A. Ditzgibbon. KinEtre: Animating the World with the Human Body. UIST 2012.

[**Garcia19**] M. Garcia, R. Ronfard, **M.-P. Cani.** Spatial Motion Doodles: Sketching Animation in VR Using Hand Gestures and Laban Motion Analysis. MIG 2019.

[**Guay15**] Guay, M., Ronfard, R., Gleicher, M., & **Cani, M. P.** (2015). Space-time sketching of character animation. ACM Transactions on Graphics (TOG), 34(4), 1-10.

[**Kim03**] T.-H. Kim, S. Park, S. Shin. Rhythmic-motion synthesis based on motion-beat analysis. ACM SIGGRAPH 2003.

[**Li21**] R. Li, S. Yang, D. A. Ross, A. Kanazawa. AI Choreographer: Music Conditioned 3D Dance Generation with AIST++. ICCV 2021.

[**Nivaggioli19**] Adrien Nivaggioli, Damien Rohmer. Animation Synthesis Triggered by Vocal Mimics. Motion, Interaction and Games, 2019.

[**Zhou18**] Y. Zhou, Z. Xu, C. Landreth, E. Kalogerakis, S. Maji, K. Singh. VisemeNet: Audio-Driven Animator-Centric Speech Animation. ACM SIGGRAPH 2018.

Expected Intern Work:

Missions:

- Provide a refined study of the current research bibliography on expressive 3D animation, and video-based animation authoring.
- Propose a general methodology to apply expressive deformers on isolated primitives and hierarchical ones with image and/or video-based inputs.
    - Categorize and enumerate the type of fundamental deformations to be taken into account in regard to expressive animation concepts.
    - Relates these deformation to degrees of freedom that can be controlled via video-based features, or sound-based features.
    - Compare this proposed methodology in regard to previous research works and interest in Animation Studios.
- Implement a proof of concept taking as input a video recording, and applying coherent deformation on simple shape primitives.

General Organization:

- Weekly meeting with the supervisor to present and discuss your advancement, and exchange research ideas and methodology.
- Participation in the weekly meeting of the VISTA team. Present and share your work advancement to the rest of the team.
- At least one onsite meeting with Dada Animation studio at the beginning of the internship. Regular monthly update to the work with them, and final presentation (possibly remotely).

Requirements:

- Master level student, or last year of Engineering School, with good Computer Science and Applied Math background.
- Followed class or performed projects in Computer Graphics and/or 3D geometry.
    - Specific knowledge in Computer Animation is a plus
    - Specific knowledge in Image Processing is a plus
- Good practical skills in programming typically in Python and/or C++. Being able to autonomously develop code interfaced if needed Blender or Unity plugins, and parsing 3D animated assets.
- Interest in Animation Studio Production. Note that 3D art knowledge or use of 3D modeler is not required, but it can be a plus.

How to Apply:

Send an email to Damien Rohmer (damien.rohmer@polytechnique) and Pascal Guehl (guehl@lix.polytechnique.fr) with the following elements:

- Your CV
- The school transcript obtained so far in master or engineering school.
- Please mention explicitly in your email:
    - The reason for your interest in the subject
    - The class and/or projects you have done in Computer Graphics
    - The name of the teachers/supervisors you had in Computer Graphics