bmlSUP – A SMPL Unity Player

Adam O. Bebko* Anne Thaler Nikolaus F. Troje

Centre for Vision Research
York University, Toronto

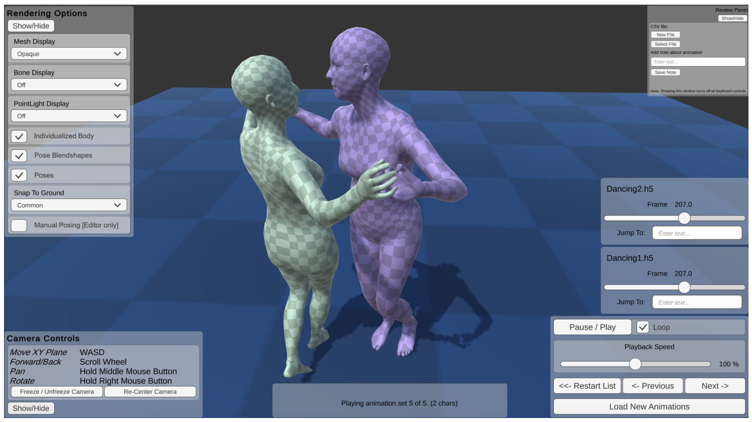

Figure 1: bmlSUP playing an example paired animation in Unity.

Abstract

Realistic virtual characters are important for many applications. The SMPL body model is based on 3D body scans and uses body shape and pose-dependent blendshapes to achieve realistic human animations [3]. Recently, a large database of SMPL animations called AMASS has been released [4]. Here, we present a tool that allows these animations to be viewed and controlled in Unity called the BioMotionLab SMPL Unity Player (bmlSUP). This tool provides an easy interface to load and display AMASS animations in 3D immersive environments and mixed reality. We present the functionality, uses, and possible applications of this new tool.

Keywords: animation, virtual characters, avatar, toolkit, Unity

Index Terms: Human-centered computing—Visualization—Visualization systems and tools—Visualization toolkits; Computing methodologies—Computer graphics—Animation—Motion capture; Applied computing—Law, social and behavioural sciences—Psychology

1 Introduction

Virtual characters are used in a wide range of on-screen applications and immersive and collaborative environments. Due to the high degree of control of the presentation and animation of the characters they lend themselves well to research on biological motion and person perception. However, historically, virtual characters suffered from unrealistic deformations at joints. Recent advances in computer graphics and statistical body models of human bodies have led to increasingly realistic virtual characters [3,5,7].

One such advancement is the MoSh method [2]. MoSh reconstructs motion and shape from optical motion capture markers and produces an animated 3D mesh using the statistical body model SMPL [3,4]. SMPL is a data-driven model. It parametrizes the inter-individual variance in body shape through a series of parameter weights, and also provides a set of pose-dependent blendshapes that improve the realism of the mesh deformations when the joints move. These pose-dependent blendshapes result in large improvements over linear blend skinning, which causes unrealistic mesh deformations at joints. These features allow the SMPL model to create realistic individualized and animated meshes.

AMASS is a large database of such animated body models https://amass.is.tue.mpg.de/ [4]. This database currently unifies 18 different marker-based motion capture datasets using the MoSh++ method and the SMPL-H model that also contains hand poses [7]. The animations are stored as animated SMPL-H parameters and include a wide variety of everyday actions and sports movements.

Currently, animations from AMASS are easily rendered only in python. With the growing popularity and power of real-time 3D rendering tools, including popular game engines, more options are needed for displaying realistic virtual humans in 3D environments. Here, we present a tool for rendering AMASS animations in the Unity game engine. The tool contains an implementation of the SMPL-H model using Unity's native blendshape and animation system Mecanim. This tool allows access to the large amount of animations provided in the AMASS dataset, and an interface to easily load them into Unity.

2 The SMPL Unity Player

bmlSUP[1] can be accessed here free and open source: https://biomotionlab.github.io/SUP/.

2.1 AMASS Animations

Animations from the AMASS database can be downloaded at `https://amass.is.tue.mpg.de`. The animations are stored in *.npz* format, which can only be accessed in python. To play the animations in Unity, the files must be converted into a C# readable file format. We provide a python tool to convert into *.h5* (preferred) or *.json* files with some example scripts.

*adambebko@gmail.com

[1]The bmlSUP player can only be used for non-commercial purposes, and falls under the same license agreement as SMPL. Use of this tool also requires citing the SMPL publication [3], `https://smpl.is.tue.mpg.de/`.

2.2 Body Model

Each frame in an AMASS animation includes the SMPL-H parameters for that frame: body pose (including hand articulations), global body translation, and DMPL dynamic soft-tissue coefficients [7]. The animation file also contains the individualized body shape parameters of the female or male SMPL-H model. Our player currently does not support DMPL. AMASS animations containing such data will still play, but the current version of our player will exclude these components. The player is structured in a modular fashion. Body shape parameters, skeleton pose, and pose-dependent blendshapes can be individually toggled and substituted.

2.3 Functionality

Animation files can be loaded individually or in batch. If a batch of animations should be played in a specific order, a *.txt* file must be included specifying the order. Multiple or paired animations can be played simultaneously by explicitly including them as a sequence in the *.txt* file. After loading the animations into the Unity player, there are several settings for playing the animations (Figure 1):

Playback Controls Controls for playback include a play and pause button, changing playback speed, a "scrubber" for jumping to a particular part of the animation, and buttons to play next or previous animation or restart list if multiple animations are loaded.

Appearance It is currently possible to toggle between three mesh rendering modes: opaque with checkerboard texture, semi-transparent, or show no mesh. Rendering of lines for bones and spheres for all joints can be toggled on and off. The left and right sides of the body can be colored separately.

Camera The camera can be explicitly positioned in the Unity editor before runtime and compiling. There are also controls available at runtime to move the camera's view (e.g., rotate, zoom in and out etc.). The controls have been designed to roughly match the controls of the Unity Editor scene view.

Reviewing It is possible to save notes about animations while viewing them using the review panel. A *.txt* file can be generated with any added notes associated with each animation. It is also possible to load and amend an existing file. This functionality can be used to annotate large sets of animations, and for simple applications requiring basic user responses.

Customization By editing the Unity project and recompiling, advanced customization options are available, including changing the background scene, the rendering and textures of the body models, and many other features.

2.4 Potential Applications

Psychology Experiments Our Unity player can serve as a template for users who want to design behavioural experiments involving realistic body models [8]. The player is compatible with the bmlTUX toolkit also created by our group [1].[2] bmlTUX provides an interface in Unity that allows users to quickly build experiments. It is designed to minimize the amount of code required to get an experiment running. The toolkit is available open source from `https://biomotionlab.github.io/TUX/`.

Self-Avatar Animation Our Unity implementation of the SMPL-H model can leverage the body shape and skeleton pose of the model independently. To determine a user's individual body shape parameters, The Virtual Caliper project provides tools to rapidly generate metrically accurate SMPL bodies based on body measurements [6] (`https://virtualcaliper.is.tue.mpg.de/`. The bodies can be either generated within Unity using virtual reality controllers, or by setting the body dimensions in a desktop application. Because the body shape parameters of the SMPL and SMPL-H model differ, the resulting SMPL parameters must be converted to SMPL-H using scripts that can be found at `https://github.com/vchoutas/smplx/blob/master/transfer_model/README.md` [3]. The skeleton pose components of the SMPL-H model can be manipulated directly, while still taking advantage of its pose-dependent blendshapes. This means that the SMPL-H bodies can be animated via Unity's Mecanim animation system while retaining realistic joint deformations (e.g., using Mixamo animations, I.K. solvers, etc.). The SMPL-H bodies can also be animated in real-time in conjunction with motion capture systems.

Mixed Reality Applications bmlSUP can also be used to leverage Unity's mixed reality support, greatly simplifying presenting AMASS animations in mixed reality applications. Potential avenues of research could include ergonomics and design testing, the growing field of fitness and health body-shape tracking, and improving body realism in gaming.

[2] A tutorial for building experiments with bmlTUX will be presented at the IEEE VR 2021 conference.

3 Conclusion and Future Work

We present a useful new tool to render and control SMPL-H body models in Unity. This allows the large amount of animations available from the AMASS database to be implemented easily in projects requiring immersive 3D environments, including virtual and mixed reality. Future development could integrate extensions of the SMPL-H model to increase realism and fidelity of the virtual characters even further, including DMPL (dynamics of soft tissue) [3], or the SMPL-X model including facial expressions [5].

Acknowledgments

The authors wish to thank Nima Ghorbani and Naureen Mahmood for their useful comments and providing an early prototype of the Unity Player and the basis for the skinned meshes. This work was supported by CFREF VISTA funding.

References

[1] A. O. Bebko and N. F. Troje. bmlTUX: Design and control of experiments in virtual reality and beyond. *i-Perception*, 11(4):2041669520938400, 2020.

[2] M. Loper, N. Mahmood, and M. J. Black. MoSh: Motion and shape capture from sparse markers. *ACM Transactions on Graphics (TOG)*, 33(6):1–13, 2014.

[3] M. Loper, N. Mahmood, J. Romero, G. Pons-Moll, and M. J. Black. SMPL: A skinned multi-person linear model. *ACM transactions on graphics (TOG)*, 34(6):1–16, 2015.

[4] N. Mahmood, N. Ghorbani, N. F. Troje, G. Pons-Moll, and M. J. Black. AMASS: Archive of motion capture as surface shapes. In *Proceedings of the IEEE ICCV*, pp. 5442–5451, 2019.

[5] G. Pavlakos, V. Choutas, N. Ghorbani, T. Bolkart, A. A. Osman, D. Tzionas, and M. J. Black. Expressive body capture: 3D hands, face, and body from a single image. In *Proceedings of the IEEE CVPR*, pp. 10975–10985, 2019.

[6] S. Pujades, B. Mohler, A. Thaler, J. Tesch, N. Mahmood, N. Hesse, H. H. Bülthoff, and M. J. Black. The Virtual Caliper: Rapid Creation of Metrically Accurate Avatars from 3D Measurements. *IEEE transactions on visualization and computer graphics*, 25(5):1887–1897, 2019.

[7] J. Romero, D. Tzionas, and M. J. Black. Embodied hands: Modeling and capturing hands and bodies together. *ACM Transactions on Graphics (ToG)*, 36(6):245, 2017.

[8] A. Thaler, A. Bieg, N. Mahmood, M. J. Black, B. J. Mohler, and N. F. Troje. Attractiveness and Confidence in Walking Style of Male and Female Virtual Characters. In *2020 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, pp. 679–680. IEEE, 2020.