# PoseMMR: A Collaborative Mixed Reality Authoring Tool for Character Animation

Ye Pan*
Disney Research

Kenny Mitchell†
Disney Research
Edinburgh Napier University

**ABSTRACT**

Augmented reality devices enable new approaches for character animation, e.g., given that character posing is three dimensional in nature it follows that interfaces with higher degrees-of-freedom (DoF) should outperform 2D interfaces. We present PoseMMR, allowing **M**ultiple users to animate characters in a **M**ixed **R**eality environment, like how a stop-motion animator would manipulate a physical puppet, frame-by-frame, to create the scene. We explore the potential advantages of the PoseMMR can facilitate immersive posing, animation editing, version control and collaboration, and provide a set of guidelines to foster the development of immersive technologies as tools for collaborative authoring of character animation.

**Index Terms:** Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Mixed / augmented reality; Human-centered computing—Human computer interaction (HCI)—Interactive systems and tools—User interface toolkits

## 1 INTRODUCTION

Animated 3D characters are widely used in games and movies, both of which are industries with vast economic and cultural impact. However, the production of 3D character animation is laborious and expensive. Today, the most common way to create 3D animated stories is to use high-end, key-frame-based animation software such as Maya, 3ds Max or Blender, with normal 2DoF mouse interfaces on 2D screens. The most time-consuming part of character animation is 3D character posing. By investigating posing further, researchers observed that the selection of body parts appears to constitute the largest part of the posing task [2]. Another widespread animation techniques considers using motion capture systems or performance-based animation. These systems were developed to overcome intrinsic limitations of 2D interfaces. However, the drawbacks of motion capture are that the physiology of performer limits the possible motions, and it requires expensive equipment, large performance spaces, skilled actors, and laborious post-processing steps [3].

Additionally, advances in VR/AR systems, together with the reduction in cost of associated equipment, have led artists and directors to explore virtual reality (VR) filmmaking and its place in the future of storytelling. But filmmakers are facing big challenges, when it comes to make 360 degree VR film, where the audience can freely look where and at what they desire at any time in the story. This audience driven exploration of a film requires new approaches to filmmaking that move us beyond traditional layout, cuts and editing. Therefore, a new methodology for storytelling in VR filmmaking is necessary.

A few VR based tools have been developed to improve the process of animation and VR filmmaking (see Table 1), but applications aimed at posing and animating CG characters are rare, and these systems are almost exclusively limited to a single user. However, as with creating animated content in VR, directorial and artistic reviews usually carried out with the director "in VR" using a headset, with other artists watching from "outside VR" on a 2D monitor. This resulted in a large perceptual disconnect between what the director and artists would see and subsequent difficulties in communicating notes in an environment where perspective matters a great deal.

Table 1: Examples of different VR animation tools

| Tools | Users | AR/VR | Aim for animating rigged characters |
|---|---|---|---|
| AnimationVR [8] | Single | VR | Yes |
| Facebook Quill [6] | Single | VR | Yes |
| Tvori [7] | Single | VR | Yes |
| Penrose Maestro [1] | Multiple | VR | No |
| Mindshow [4] | Single | VR | Yes |
| Disney PoseVR [5] | Single | VR | Yes |

To address these issues, we created a cross platform character posing, sequence management and network playback tool that allows any number of artists and directors to enter an experience together and review the content in MR. Built on previous approaches (see Table 1), combined with collaborative MR technologies and with direct feedback from in-house animators, PoseMMR was designed to address 3D character posing and collaboration. The 6DoF input devices, stereoscopic view with spatial cues, and multiple user perspectives help artists and directors with several tasks (e.g., cooperating to adjust the pose of a shared 3D character, or entering an experience together to review the content in shared environment). The highlights of the PoseMMR are as follows:

- In AR users can interact with the shared real world and the virtual world simultaneously, where spatial cues are provided, and that natural collaboration is facilitated.
- For the first time, collaborative animation editing in MR, only using commercially available HMDs, allows users to monitor all others' edits in real time.
- Multiple users can collaboratively pose and animate 3D characters in both co-located and remote scenarios.
- We address policies to automatically merge and solve concurrent editing conflicts.

## 2 IMPLEMENTATION

For the proof-of-concept implementation, we provided each user an AR system, using HTC VIVE Pro Virtual Reality Headset, driven by a Windows 10 desktop computer (Intel Core i7- 6700K at 4.0 GHz, 16 GB RAM, and NVIDIA GeForce GTX 1070). We then used the video see-through (VST) mode of the HTC Vive Pro's stereo camera (captured in VGA@90Hz) to create the AR experience. These AR systems were then networked, enabling multiple users to

*e-mail: ye.pan@disney.com
†e-mail: k.mitchell2@napier.ac.uk

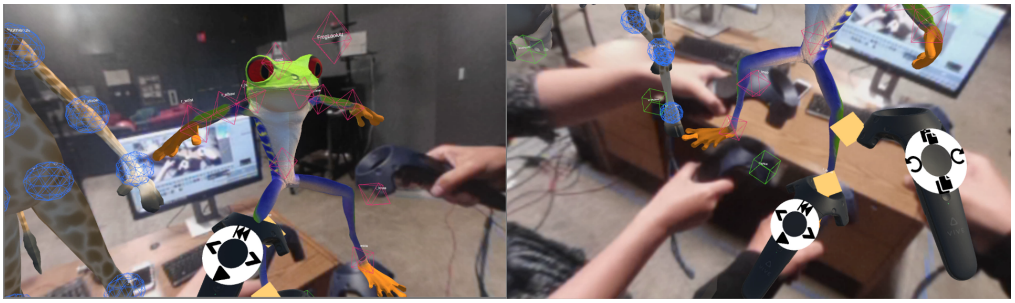

Figure 1: A pair of simultaneously captured images from the first-person view of each user within the dyad in mixed reality environment. Each user can cooperate to adjust the pose of the shared character naturally in 3D using inverse kinematics. Left: posing the left leg of the frog. Right: posing the right leg of the frog.

work with poseable characters in a shared environment, and interact with each other in a face-to-face arrangement. We developed our software using the Unity game engine version 2018.3 with SteamVR for Unity and Vive SRWorks SDK. Note that our prototype can be applied to any commercially available AR headset.

**Immersive Posing** Two main approaches exist for controlling kinematics in character posing: inverse kinematics (IK) and forward kinematics (FK). With IK control, limb rotations are computed based on the position of the end effector. In FK control, the limbs are rotated directly. Similar to state-of-the-art animation software (such as Maya and 3ds Max), we include three types of control nodes: FK, IK and global control. While holding the trigger with the VIVE controller touching the node handle (see Figure 1 displayed in the wire frame.), animators can grab the object and move or rotate it (Note that pink for IK node which can only be rotated and translated; blue for FK node which can only be rotated; green for global control which can be rotated, translated, and scaled).

**Animation Editing** Consulting frequently with our in-house animators, we created additional animation editing functions without leaving the 3D environment, including setting keyframes after posing the character, saving the recording of the movements into an animation clip, reviewing the content in the shared environment.

**Networking Animation Poses** Networking in the prototype implementation of PoseMMR was enabled by Photon Unity Networking (PUN), and aural communication was enabled by Photon Voice. The photon server links the environment to one of its internal servers. Once connected, clients can connect to different rooms through the room id. After a connection is established, the photon network monitors movement change in the environment so that everyone's motion is visible to all.

**Live Collaborative Animation Editing** With the ability to simultaneously edit animation poses on a shared live immersive view, the potential of conflicts among collaborators' changes arises and these must be addressed formally to maintain a coherent animation repository.

## 3 Evaluation

PoseMMR was evaluated with 3D character animation experts. Many features of the classic Autodesk Maya could be translated into 3D environment with little effort or novelty, however, the 3D device only outperformed the 2D interface for certain types of tasks. The goals of the evaluation were to determine the use cases, to identify problems, and to discuss new features for future versions. Below is a list of the design recommendations.

- It is more natural to manipulate 3D characters and to navigate freely in 3D space using 3D interfaces.
- The multi-manipulator controllers removed inefficiency and distractions to allow artists to focus on their craft.
- Whilst a controller remains on a selected joint, a key or command that toggles between FK and IK modes is recommended.
- If collaborators want to experience a virtual environment from different viewpoints or scale, then immersive VR may be the best choice. However, if the collaborators want to have a face-to-face discussion while viewing the 3D characters an AR interface may be best.
- Collaborative MR experience is particularly addressed during the review process, which require the input of many people, including but not limited to the director. It reduces the frequency of context switches between VR and 2D monitors.

## 4 Conclusion

The contribution of the paper is twofold: Firstly, we present the PoseMMR system which combines existing technologies of collaborative MR and character animation editing - making it possible for multiple users collaboratively to pose and animate CG characters in 3D space with the 6DoF controllers. Secondly, we evaluated the ability of PoseMMR to collaboratively work with poseable rigs in a MR environment. We also explored how to expand our current workflows, and discussed the benefits and potential of collaborative MR for our future animation toolsets.


## Acknowledgments

The authors wish to thank Jose Gomez Diaz, Justin Walker, Douglas Fidaleo, Jerry Rees, Leslie Evans, Joe Hager, Kyna McIntosh, Lanny Smoot and Jon Snoddy for the feedback on our prototypes.


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