REC: A Unity Tool to Replay, Export and Capture Tracked Movements for 3D and Virtual Reality Applications

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Figure 1: Tracked movements being recorded and replayed on a second virtual character.

ABSTRACT

We present REC[1][2], a Unity open-source tool for developers and researchers to record, export and replay the movements of virtual reality users and virtual characters. Recording both real-time body tracking and animations, this tool makes it possible to export skeletal data in a comma-separated values (CSV) file allowing to process and analyze users' movements. We also provide a feature to reload and replay saved movements directly from the CSV file on virtual characters in a 3D environment.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; • **Computing methodologies** → **Motion processing**; **Motion capture**.

KEYWORDS

Virtual Reality, Motion Capture, Animation, Unity

[1]Video: https://youtu.be/JoGoU34bTAk
[2]Public Repository: https://github.com/GeoffreyGorisse/REC

1 INTRODUCTION

Numerous human-computer interaction (HCI) studies, especially virtual reality experiments, rely on partial or full-body tracking technologies. For instance, embodied paradigms often use inverse kinematics or motion capture to allow participants to control virtual characters (avatars) in real time [González et al. 2020; Gorisse et al. 2019]. Indeed, it is demonstrated that visuomotor synchrony between the movements of the real body and the perceived movements of the virtual body induces a sense of body ownership and agency [Kokkinara and Slater 2014]. Body ownership and agency are known to be two sub-dimensions to the sense of embodiment in immersive virtual environments [Kilteni et al. 2012]. While visuomotor synchrony is mainly used to embody and control avatars in virtual reality experiments, most metrics of such studies remain subjective. While subjective analyses must be considered in experiments assessing user experience in virtual environments, there is an increasing interest and need toward developing and making behavioral analyses more reliable. Motion analyses can therefore provide interesting clues regarding users' behavior in virtual environments. In this context, this poster introduces REC, a tool developed for the real-time 3D engine Unity to assist us in our virtual real-ity experiments based on embodied paradigms. This tool enables us to record, export and replay users' movements performed in virtual environments using body tracking technologies, including consumer-grade VR devices. We wanted it to be open source and freely accessible for researchers who can benefit from virtual characters' skeletal data for motion processing and who can take advantage of reloading and replaying this data for additional post-hoc subjective analyses. While the primary goal of this tool is to

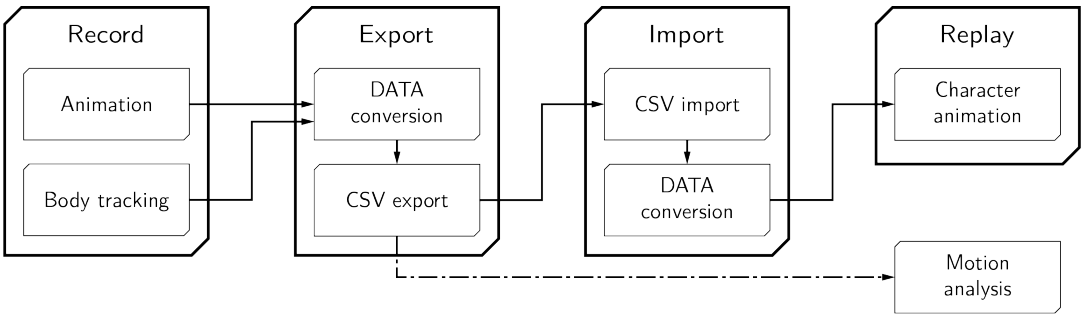

Figure 2: REC pipeline overview.

help HCI and VR researchers, it can also be used and derived by developers and artists for creative purposes to save and instantly replay users' movements or characters' animations in 3D applications (Figure 1).

2 REC TOOL

In this section we will go through the different steps to integrate and leverage the features of the REC open-source tool we developed for Unity[3]. REC enables the recording of virtual characters' skeletal data at an adjustable frequency (60 *Hz* by default) and exporting of the data in a CSV file that can be used both to process users' motion for behavioral analyses and to replay the recorded movements on virtual characters that share the same skeleton in the 3D engine (Figure 2).

2.1 Movements Recording

To capture a virtual character's motion, one must tag the bones in the hierarchy to be recorded. We chose to use the Unity's tagging system to select and extract relevant bone data for behavioral analyses depending on the experimental design (e.g. partial or full-body tracking). The tagging system can be replaced if needed (e.g. inspector exposed list), but we recommend not using the layer system as it is often used for physics and collision matrix purposes in the engine. Once tagged, bone local rotations will be recorded along with the root bone position.

The project includes an event manager that handles the recording period before exporting the data. While the video introducing the REC tool presents a user performing movements tracked in real-time, the open-source project shared with this publication uses an animated character to avoid sharing inverse kinematics third party assets. However, the recording method remains the same and is applicable to any kind of animation or tracked movements. By default, data will be exported at the end of the character animation.

2.2 Data Export and Import

We developed a utility class with generic functions to write and read comma-separated values (CSV) files. We chose this file format as most statistical analysis software can handle such data files. This format is easily readable and directly accessible in the *StreamingAssets* folder of the application. The exported file contains the following converted data:

- Character's scale.
- Recording delay in milliseconds (16.6 *ms* or 60 Hz by default).
- Recording time for each set of data.
- Character's position and rotation.
- Root bone local position.
- Selected bone local rotations.

The CSV file can be reloaded from the dedicated folder. String lists containing rotation and position data over time are converted to Vector3 (*x, y, z* Euler angles).

2.3 Movements Replaying

To replay the recorded motion, the loaded data are applied to the selected virtual character's skeleton based on the recording frequency. The names of the recorded bones are automatically matched based on the selection made using the tagging system during the recording stage. It should be noted that the recorded movements can be directly replayed as soon as users have finished performing their movements, as the process is not resource-intensive.

3 LIMITATIONS AND FUTURE WORK

Whereas we believe the REC tool developed for Unity could be useful to HCI and VR researchers and developers, there are still some limitations that have to be taken into account. First, while it is possible to apply the recorded motion to different virtual characters, they must share the same skeleton hierarchy and naming convention. Second, although the tool could be used to animate virtual characters, it does not offer as much flexibility as an animation pipeline (blending, retargeting, etc.). Despite these limitations, future research could benefit from the REC tool features for conducting behavioral analyses of users embodied in immersive virtual environments. We encourage researchers to test, share, edit and provide us with feedback to make this tool useful to the research community.

[3]The initial release and demo project of the REC tool was developed using Unity LTS 2020.3

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