Artificial Intelligence and Human-Computer Interaction
Y. Ye and P. Siarry (Eds.)

doi:10.3233/FAIA240171

Research on Animation Technology Innovation Based on Metaverse Platform

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Abstract. The development of virtual reality technology and its application in the Internet has formed the concept of metaverse, which has become not only a new form of next-generation Internet, but also a new computing platform. The convenient interactivity, immersive nature and powerful cloud computing capability of the metaverse platform provide a new way and method for the creation of digital animation. The project creates 3D characters and scenes in the metaverse platform, and assembles multiple performers wearing VR devices in the scenes through the network to control the avatars in the metaverse scenes with natural performance movements, combined with virtual filming to complete the animation shots. In this paper, an animation film creation scheme based on the metaverse platform is proposed from several aspects, including scheme design, virtual character, scene modeling, virtual filming and case creation. It realizes the virtual performance function of real-time control of animation characters with full-body motion capture and facial expression capture technology; it realizes the virtual shooting function of real-time rendering output and live animation program; it realizes the network multi-person work mode of animation creation team of "exotic and simultaneous". It redefines the creation process of animation in the meta-universe perspective, which is an important innovation for the development and teaching reform of the animation profession in the new era.

Keywords. Virtual Reality, motion and expression capture, metaverse platform, animation technology innovation

1. Introduction

With the continuous development of animation technology and the progress of science and technology, the creation technology of film and television animation creation has gone through the stages of hand-drawn animation, computer-aided production animation and real-time animation of game engine. And motion capture technology has become an important technical support for animation film production since the American animation film Avatar. The game engine provides powerful real-time rendering ability to make the animation production faster; motion capture technology can accurately capture the real human body or object movement data, and apply to the virtual character or object movement, making the character's movement more realistic and natural. However, since the creation process of animation is carried out on a stand-alone platform, the motion and expression data of each character are collected and loaded separately for the second time,

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which causes problems such as motion and expression data cannot be strictly synchronized, excessive workload and low efficiency in the production process. Based on virtual reality technology and Unity 3D real-time rendering game engine, this paper applies the meta-universe platform (the meta-universe platform is a platform that allows users to enter the virtual world in the form of personalized avatars to communicate and explore with other users) to control the virtual performance of animated characters in real time by using the full-body motion capture and facial expression capture technology, and combining with the real-time interactive virtual camera to realize the real-time Rendering output, to realize the animation creation team "exotic and simultaneous" network multiplayer work mode, so as to realize the comprehensive innovation of animation creation process.

2. Program design

2.1. System principle

The research on technological innovation of animation based on metaverse platform is to gather multiple performers wearing motion capture (including body movement, hand movement, mouth and eye movement) devices through the network, control the animated characters to enter into the relevant metaverse platform for performance, and output by a virtual camera based on the metaverse platform for virtual filming. The system principle is shown in Figure 1.

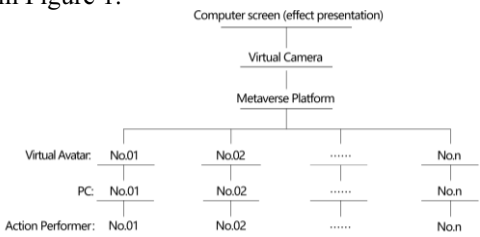

Figure 1. System principle.

2.2. Technical lines

Through the analysis of the cross-linkage between metaverse platform and animation creation and related literature research, a structured system development line was used to complete the production from the following links, and the technical line is shown in Figure 2.

Figure 2. Technical line.

2.3. Platform construction

When performing full-body motion tracking, appropriate software and hardware support are required [1].

Software: Steam VR software, SRanipal Runtime software for HTC Vive, VRCFaceTracking software, and the Metaverse platform. Steam VR is a virtual reality (VR) software platform developed by Valve Corporation that provides support and software solutions for VR headsets using HTC Vive, Valve Index, and other compatible devices; SRanipal Runtime is software developed by VIVE Corporation for use with corresponding eye-tracking devices such as the VIVE Pro Eye, which provides a set of runtime tools and features to support the development and operation of eye-tracking applications that can be used directly in Unity 3D and Unreal Engine; VRCFaceTracking is a community-driven project software for facial tracking applied to the Metaverse platform created by the community and available for free.

Hardware (HTC Vive Pro Eye hardware as an example): 1 HTC Vive Pro Eye head-mounted display, 1 HTC Vive Pro Eye face tracker, 3 motion trackers, 2 or more positioning base stations, 2 Valve Index finger tiger grips.

Place the positioning base station diagonally in an open room with a minimum size of 2m*1.5m, and the height of the positioning base station is not lower than the height of the wearer.Three motion trackers were tied to the tops of the wearer's feet and the back of the tailbone; the HTC Vive Pro Eye face tracker was plugged into the head-mounted display, running Steam VR and using the eye-movement calibration program; and the Valve Index finger tiger grips were worn on each hand. As shown in Figure 3.

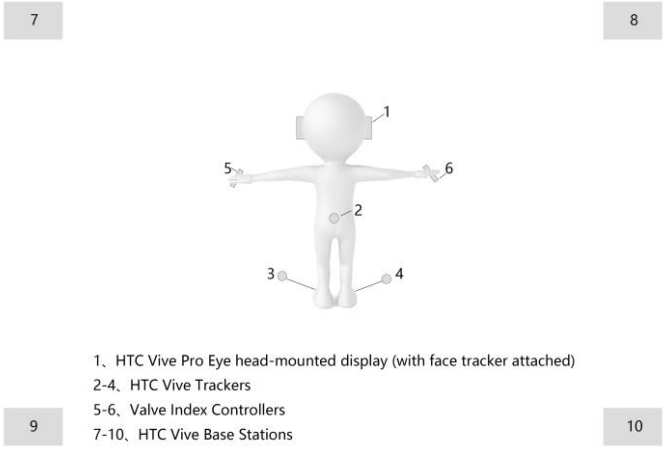

Figure 3. Full-body motion capture solution.

3. Virtual characters

The characters described in this article are the humanoid characters in animation, for the avatars (Avatars) in the meta-universe. Character modeling is usually created by VRoid Studio, Character Creator 4, DAZ Studio and other shortcut software.

3.1. Blend shape standard

In facial control, Blend Shape is usually used to simulate different facial expressions, such as smile, anger, sadness, etc. Due to different hardware devices and different standards for Blend Shape by each device manufacturer, the Blend Shape standards for virtual characters based on the metaverse platform are different, and the more common ones are SRanipal, ARKit [2] and Unified Expressions.

3.2. VRoid Studio quick character modeling

VRoid Studio is a free software developed by Pixiv, a Japanese technology company, for creating 3D avatar models [3]. The virtual character models created are in VRM format, and the corresponding plug-ins are required when modifying the models using 3D software.

VRoid Studio creates virtual character avatars:Open VRoid Studio software, create a new virtual character, select a male or female model template and enter the production interface. The model creation interface is divided into six main sections, namely "Face", "Hairstyle", "Body", " Outfig", "Accessories", and "Look".

"Face": face adjustment board, you can adjust the face shape, eye size, color, position, nose size and position, mouth size and position, single and double eyelids, eyelash color, position and other facial related data; "Hairstyle": hair adjustment Board, you can combine multiple hairstyles, you can also create and upload your own custom files in line with the software format; "Body": body adjustment board, you can adjust the head and limbs, such as fat and thin, height and skin color, etc.; "Outfig": clothing modification board. can adjust clothing-related wear, including suits, tops, pants, skirts, ties, shoes, etc.; "Accessories": accessories to add the board, can add glasses, animation ears, etc; "Look": the overall effect adjustment board, can Adjust the light intensity, shadow contour, etc., in which, all the textures can be customized to modify. After the production is finished, export VRM format.

VRoid Studio virtual character creation modification Blend Shape: VRoid Studio will automatically add the standard Blend Shape of the metaverse platform applying Oculus Lipsync technology, no need to add it manually, but if you need to add face capture then you need to modify the Blend Shape manually, take Blender as an example: as the character model is in VRM format, Blender itself cannot open VRM directly format, so you need to install the VRM-addon-for-blender plugin. After testing, when the Blender version is 2.93.18, the addon version is 2.15.21 available.

Blend Shape is modified in the following way: First, view the Blend Shape of the virtual character model itself. select the Face hierarchy, view the existing Blend Shapes in the Object Data Properties panel, select any Blend Shape, and use sliders. If you set the weight value to 0, the shape will be the original shape, and if you set the weight value to 1, the shape will be exactly the shape of the Blend Shape. Second, check whether the Blend Shape of the virtual character model itself is partially available for face capture. For example, the model made by VRoid Studio itself has "Fcl_EYE_Close_R" Blend Shape, which is the same as the standard "Eye_Blink_R" shape of SRanipal. the name of the former can be changed to the latter. Finally, the other Blend Shapes for making virtual character models for the SRanipal standard. As in the SRanipal standard "Mouth_Smile_Right", this deformation shape can be interpreted as raising the right corner of the mouth, the virtual character produced by VRoid Studio itself does not have this Blend Shape, due to manual production. The specific operations are: create a new

Blend Shape at the Face level, name it "Mouth_Smile_Right", select the Blend Shape and adjust the value (brightness) to 1; enter Blender's "Edit Mode" and adjust the shape of the model's chin in 3D view, using various deformation tools, such as vertex shift, stretch, scale, etc.; enter Blender's "Weight Mode" to see if the deformation shape is weighted correctly; enter "Object Mode" to test the deformation shape, use the slider or manually enter the value to see the deformation shape [4].

Repeat the above steps to write the SRanipal standard to the virtual character. SRanipal has a total of 52 standard Blend Shapes [5], which are affected by computer performance, so some of them can be selected for production, and the output format is VRM.

3.3. Virtual avatar upload

Selecting the VRChat platform for animation creation requires Creator Companion and Unity 3D development tools [6].

To upload virtual characters made by VRoid Studio, you need to add the URL of V RM Converter for VRChat in Creator Companion software. VRM Converter for VRCh at can directly convert virtual characters made by VRoid Studio in VRM format to adap t to VRChat Meta-universe platform to upload prefabs directly. To add the URL of the plugin, add "(https://esperecyan.github.io/VRMConverterForVRChat/registry.json)" to Packages in Settings [7].

Launch the Creator Companion tool, create a new project with the Avatars template applied, jump to the resource package management page [8], add Avatars 3.0 Manager and VRM Converter for VRChat, Avatars 3.0 Manager is a tool to manage virtual character layers and parameters [9].

Import the virtual character in VRM format into Unity 3D, select the imported file, choose Duplicate and Convert for VRChat from VRM0 in the menu bar, and click Duplicate and Convert in the pop-up window.The virtual character models created by VRoid Studio are fully adapted to this metaverse platform, and the virtual character models created by VRoid Studio software will automatically add the basic component VRC Avatar Descriptor for uploading to the metaverse platform, open the upload panel in the Unity 3D menu bar and upload directly. panel in the Unity 3D menu bar and upload it directly. The virtual character model uploaded by this method cannot be captured by face.

3.4. Add face capture

Upload avatars that can perform facial capture, Avatars 3.0 Manager, VRCFaceTrackin g and lilToon plugins are needed. Avatars 3.0 Manager can be used to copy and clone a nimation controllers; VRCFaceTracking is a face tracking template to simplify the prod uction process; lilToon is a cartoon style shader. After testing, Avatars 3.0 Manager_ve rsion 2.0.23, lilToon_version 1.3.7 and VRCFaceTracking_Templates_v3.6.6 can be us ed together [10].

Import the plug-in and virtual character model into Unity 3D, open the Avatars 3.0 Manager window in the Unity 3D menu bar, and select the model made by VRoid Studio at Avatar.Avatars 3.0 Manager is divided into three sections: "Layers", "Parameters" and "Write Defaults "Layers" and "Parameters" are the relevant sections for uploading, "Layers" is for The role of "Layers" board is to copy the animation controller, and the role of "Parameters" board is to clone the template parameters [11].

The Layers section is divided into eight parts: "Base", "Additive", "Gesture", "Action", "FX", "Sitting", "Tpose" and "IKPose", and only the "FX" and "Additive" parts are covered in the upload.

FX is a special layer in which material animations, shader property animations, or blended shape animations, etc. can be replicated. In the FX layer, the FX Full Face Tracking WD data from the VRCFaceTracking plugin adapted to the SRanipal animation controller and the animation controller vrc_AvatarV3HandsLayer data included in the Metaverse Platform SDK are merged into the character's original animation controller;Additive,Select Use Custom Animator Layer at Additive, place the Additive Eye Tracking WD in the VRCFaceTracking plug-in for SRanipal into the Controller, and check EyeTrackingActive, LeftEyeX, RightEyeX, EyesY, Expression Parameter and Synced.After the Layers board is created, select the Parameters board and copy the Para Full Face Tracking 123bit data from the VRCFaceTracking plugin SRanipal to the original parameters.

Facial expression switch control: Open the animation controller applied to the FX layer of the model, select Left Hand, and add facial expression switches (boolean variables) to the connection lines connecting Fist, Open, Point, Peace, RockNRoll, Gun, and Thumbs up in Any State respectively. Click the plus sign at Conditions, select "FacialExpressionDisabled" in the first column, and select false in the second column, and add each of the connection lines. Right Hand also needs to be modified.

Add the facial expression capture menu: select the VRCExpressionsMenu at the Menu of the virtual character model VRC Avatar Descriptor component, create a new menu, change the name to face, select the corresponding image, change the category to Sub Menu, and dispose of the VRCFaceTracking plugin SRanipal in Sub Menu into Face Tracking Control.

If the upload button is grayed out, you need to remove the shown in missing parameter error report from the Face Tracking Control menu and re-upload. When Update Complete appears, the upload is complete.

4. Scene modeling and uploading

Scenes can be made with modeling software such as 3ds Max, Maya, Blender, etc. and export the made scene resources to Unity 3D recognizable file categories, such as FBX format files. Scenes can also be made and modified in Unity 3D, which has built-in tools such as terrain editor, lighting, skybox, particle system, etc. to quickly model scenes. After the scene is built, it needs to be uploaded to the metaverse platform to form a virtual world, which is a workspace for virtual performances and filming. The following is an example of the terrain creation tools application that comes with Unity 3D.

The scene upload also uses Creator Companion and Unity 3D tools. Open Creator Companion to create a new project, select Worlds on the Create page and open the project without adding extra plugins on the Add Resource Pack Management page.

Create a Terrain in the Hierarchy panel, select Terrain in the Inspector panel, apply the paint Terrain tool, Brushes to adjust the brush shape, Brush Size to adjust the brush size, and Opacity to adjust the strength size [12]. You can add plant resources to the terrain tool at paint trees, click Edit Trees, select Add Tree, and in the pop-up window, drag the plant resources into the Tree Prefab and click Add. The tool allows you to use the brush tool to quickly add a large range of plants without worrying about whether they are planted on the floor or not; In the "Terrain Settings," specifically in the "Mesh

Resolution" section (located on the Terrain Data), you can adjust the terrain size, maximum height of convexity, and other settings.Detect whether the resources in the scene have collision detection, such as the ground, walls, etc.

When the scene model is finished, search for the VRCWord prefab in the Project panel and put it into the scene. The location of this prefab is the initial location of the metaverse virtual character into the scene. Open the Upload panel and click Upload, when Content Successfully Uploaded appears, it means the upload is successful [13].

5. Virtual shooting

Virtual filming is a technique that is implemented through virtual characters in a metaverse. It uses a combination of a computer and a virtual reality head-mounted display to allow the cinematographer to enter the metaverse platform and interact with the virtual environment within it. This technology allows the cinematographer to control the movement of the virtual character through the movement of the head-mounted display, while the computer's screen reflects the movement of the head-mounted display in real time, like a virtual camera.

The virtual shooting process is as follows: First, the cameraman moves the head-mounted display, which is equipped with sensors that sense the device's own motion and changes in real time. When the cameraman enters the metaverse platform using the head-mounted display, the motion of the device is tracked in real time through the sensors, including rotation, tilt and turn, and these motions are translated into a real-time picture in the head-mounted display. Second, the computer updates the picture of the virtual environment in real time according to the movement of the camera operator's head-mounted display. Just select the appropriate software to record.

6. Cases and tests

Produce a full animation using innovative animation techniques based on the Metaverse platform and test the smoothness and responsiveness of the Metaverse platform integration system.

6.1. Cases

Creative Script: A couple's argument over work and family responsibilities. The female lead works overtime and wants the male lead to pick up the kids and bring them home, but the male lead is busy with work. Both parties are emotional and fail to reach a consensus. Later, the male lead realizes that he has ignored his mother's messages, prompting the two to reflect on the importance of family.

Art design and resource production: Virtual character modeling using VRoid Studio fast modeling, imported into Blender to add Blend Shape; scene production using a combination of Maya and Unity 3D production, resources to complete the scene through the Creator Companion and Unity 3D upload to the meta-universe platform.Virtual Performance and Filming: Multiple performers wear motion capture devices and enter the metaverse platform, with different wearers choosing different virtual characters and simultaneously entering a virtual camera for virtual filming.

6.2. Tests

After the animation technology platform based on metaverse platform is built and resources are uploaded, the smoothness and responsiveness of the integrated platform needs to be tested. Smoothness is assessed by recording the frame rate (Frames Per Second (FPS)) of a 1-minute motion capture of the same character in a different scene and a 1-minute motion capture of a different character in the same scene, with higher frame rates providing smoother animations and more detailed motion capture effects; Response speed was tested by recording different action response times in the same scene. Lower response times indicate that the integrated platform is able to respond more quickly to the action performer's commands. Computer configuration: RTX3070 GPU R7-5800H CPU.

Smoothness:

Table 1. Smoothness test Table 1 (Unit: FPS).

Scene Complexity / Number of times	Simple	General	Complex
1	90	76	60
2	90	75	62
3	90	79	65

Table 2. Smoothness test Table 2 (Unit: FPS).

Avatar Complexity / Number of times	Simple	General	Complex
1	90	80	75
2	90	79	71
3	90	76	69

Scene complexity is affected by the size of the scene and the number of special effects (e.g. particle effects) used; character complexity is affected by the number of mixed shapes. Tests show that the more complex the scene and character, the lower the frame rate; the simpler the scene, the higher the frame rate. As shown in Tables 1 and 2. In general, the fluency is less affected by the complexity of the character and more affected by the complexity of the scene. The minimum frame rate is 60 frames per second, which can satisfy the smoothness of motion capture and animation.

Reaction speed:

Table 3. Reaction speed test table (Unit: milliseconds).

Action Category / Number of times	Facial motion capture	Body motion capture
1	46	51
2	53	48
3	51	45

The character action response time was basically stable at 50 ms, and the facial action response time and body action response time were higher than 50 ms once in each of the three tests, and no more than 3 ms above and below. As shown in Table 3. In general, the action performer's movements were almost and immediately reflected accurately on the screen.

The creation of animation cases and tests on the smoothness and responsiveness of the integrated platform fully illustrate the feasibility of the integrated system to meet the requirements of character animation production.

7. Conclusion

This research provides a set of technological innovation solutions for animation based on the metaverse platform, providing powerful tools and guidance for metaverse animation creators. Through the research of this paper, the techniques of virtual character creation, standards, scene creation, uploading and integration, as well as the methods of virtual shooting and integrated creation are discussed in depth. These solutions and methods provide rich and diverse creative tools for metaverse animation creators, and promote the innovation and development of animation technology on the metaverse platform. With the development of time comes the advancement of technology, and future research can further explore the technology and creation methods of metaverse animation to meet the growing creative demand and drive further development and innovation in the field.

Acknowledgements

Thanks to everyone involved in the project. Funding: This work was supported by the Natural Science Foundation of Gansu Province 2022 Fundamental Project, titled "Research on Animation Technology Innovation Based on Metaverse Platform" (Grant No. 22JR5RA357).

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