Paper Parametric modeling of digital human based on Unity

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ABSTRACT

Traditional mass manufacturing is unable to meet the needs of customers in the current era of material abundance, and product customization is more popular currently. What modern product's man-machine design process needs is a kind of human body model that can really participate in the design process and play an evaluation and decision-making role in the calculation, selection and determination of man-machine parameters of product form. Therefore, the parameterized modeling of virtual human body needs to be able to generate the human body model of corresponding geometry and size quickly, which serves for virtual simulation and ergonomics design. The method proposed in this paper is to solve the problem of quickly generating customized digital mannequin. This paper realizes the import and parameterization of digital human model based on Unity. At the same time, this paper

investigated UMA parametric modeling method in Unity. UMA and the linear regression adopted in this paper can not only realize parametric modeling, but also realize skin changing and other functions. However, both the linear regression and UMA proposed in this paper are time-consuming to change the digital human model and there is some error between the model and the real person.

Keywords: Human·body·model, Virtual·simulation, Parametric·modeling, Unity·Multi-purpose·Avatar, Man-machine·design

INTRODUCTION

Due to the close relationship between virtual person and human, virtual person technology has been applied in all aspects of today's society. Virtual human simulation technology is an important application direction of virtual human technology. Using virtual human simulation technology can get rid of the dependence on human experiment in some fields. Virtual human simulation technology has broad application and development prospects.

(1) Military field

Virtual human technology has been gradually applied in the military field (Muslim E et al. 2019), mainly applied in simulating virtual battlefield environment reconstruction (Fidler B D, 2020), simulating individual soldier training, simulating tactical training and other military drills. Virtual system has realistic and three-dimensional interactive immersion simulation experience effect, which can simulate the military exercise effect of virtual human parametric modeling and motion generation technology research to the greatest extent. The development and application of virtual battlefield system can not only reduce the cost of military training, but also improve the security of training, greatly reduce the loss of personnel and equipment, and also better realize the deployment of military strategy and tactics. Moreover, virtual single soldier combat training realized by virtual human action simulation technology can effectively simulate the training process of soldiers, and human factor analysis and evaluation can be added to complete the human factor evaluation of whether the training process will cause damage to personnel, so as to achieve the effect of optimizing training methods.

(2) Medical field

Virtual human simulation technology has been gradually applied in the medical field (A V C et al. 2020). The main applications include (Lebdai S et al. 2020) medical teaching (Ralte S and Bhattacharyya A. 2017), virtual surgery platform , virtual rehabilitation training and tumor treatment (Mark T et al. 2019). The virtual surgical platform mainly collects the information of doctors' hand movements through the device and performs virtual surgical operations combined with the surgical platform in the virtual scene. Through the virtual

surgical platform, doctors can more truly experience the surgical process and become familiar with the operation, which can not only enrich the surgical experience of doctors, improve the medical level of medical practitioners more quickly, but also greatly reduce the risk and cost of real medical trials. Virtual rehabilitation training mainly realizes the synchronization of patients' posture with virtual characters through the simulation and simulation of patients' human movements, so that patients can complete rehabilitation training more effectively and actively in the autonomous interactive movement with virtual environment.

(3) Entertainment

In recent years, with the rapid development of virtual reality technology in the field of entertainment, the application of virtual human technology is also increasing, such as 3d animation (Giacomo T D et al. 2004), movie special effects (Rocío C, 2014) and motion sensing games based on human posture recognition .

METHOD

(1) Development Platform

The development platform used in this paper is Unity and the programming lan-guage is C#. Unity is a real-time 3D interactive content creation and operation plat-form. All creators, including game development, art, architecture, car design, film and television, use Unity to bring their ideas to life. The Unity platform offers a comprehensive suite of software solutions for creating, operating and monetizing any real-time interactive 2D and 3D content on mobile, tablet, PC, game console, augmented reality and virtual reality devices.

(2) Linear Regression

Unity has a scripting API called HumanBodyBones to describe human body bones, where digital human models are divided into LeftUpperArm, LeftUpperLeg, Neck, Head and so on. By capturing these joints, people can zoom in and out. However, there are two problems with the arbitrary zoom in and out. One is that the changes of digital people appear unnatural and the arm length may exceed the normal threshold. The other is that there is no data support. Therefore, by using the general human height, arm length, hand length and other data, we carried out linear regression on these data, and controlled the threshold of arm length and hand length corresponding to each height to prevent the occurrence of "freak human". Finally, these data are applied in the program to realize the parametric modeling based on linear regression. The parameters studied in this paper include human height, arm length, hand length and eye height.

(3) Unity Multipurpose Avatar

Unity Multipurpose Avatar (UMA), is an open avatar creation framework, and it provides both base code and example content to create avatars. Using the UMA pack, it's possible to customize the code and content for our own projects, and share or sell our creations through Unity Asset Store. As shown in Figure 1, UMA is designed to support multiplayer games, so it provides code to pack all necessary UMA data to share the same avatar between clients and server.

The key parts of this method are Slot, Overlay, DNA and Race. Slot is the mesh, which is the basic unit of character. An Overlay is a texture that is placed over the mesh and acts as the skin of the character. DNA is a set of parameters that change shape rather than biological DNA; Race is a group of slots that links to a specific mesh for men and women.

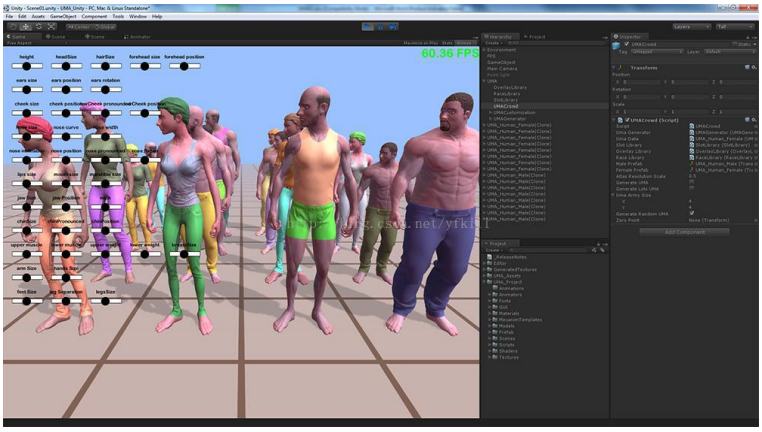

Figure 1. The UMA interface

RESULTS

In this paper, the data of human height, arm length, hand length and apparent height were queried, and groups between 160cm and 180cm in height were selected. The dimensions of each parameter are shown in Table 1. By linear regression fitting of each parameter, the relationship between height and arm length, hand length and apparent height was obtained, and parametric modeling is finally realized in Unity. As shown in Figure 2, the left and right sides are the changes of digital man when his height is 170cm and 178cm, respectively. At the same height, arm length and hand length can also be adjusted to some extent. The adjustment range of arm length is ±5cm and hand length is ±1.5cm.

Table 1: Digital person parameter size corresponding table (cm)

Parameter	Min	Middle			Max
Height	160.0	165.0	170.0	175.0	180.0
Arm length	51.0	53.5	56.0	58.5	61.0
Hand length	17.5	18.0	19.0	20.0	20.5
Eye height	149.0	154.0	159.0	164.0	169.0

Figure 2. Comparison before and after parameterization

UMA provides many parameters for developers to use, such as eye size, beard, eyelashes and so on, but this paper only selects height, arm length, hand length and visual height, which is convenient for comparison with parametric modeling based on linear regression method. Figure 3 and Figure 4 are the snapshots before and after UMA parameterization.

Figure 3. Before UMA parameterization

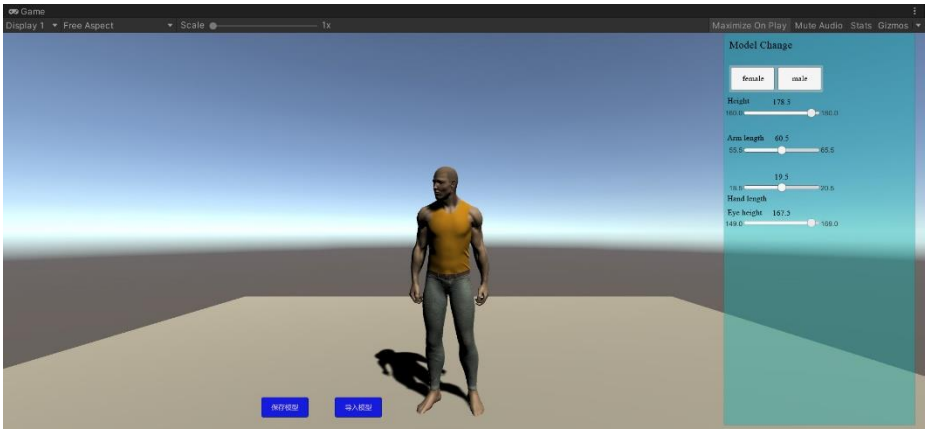

Figure 4. After UMA parameterization

CONCLUSIONS

In this paper, the parameterized modeling of human body based on Unity was realized by two methods. The first method is the parameterized modeling method based on linear regression. The key of this method is to carry out linear regression on the parameters and find the relationship between the parameters, so as to ensure the effectiveness and naturalness of the parameterization. The second method is para-metric modeling based on UMA. The key of this method is the four parameters Slot, Overlay, DNA and Race. If users master the essentials of the four parameters, they can realize parametric modeling. UMA can be reused

multiple times for the same role. This method is often used in some multiplayer games.

However, both linear regression and UMA have certain limitations, the most important of which is that the replacement of digital human model is complex and time-consuming, and some more research work is needed. In addition, there is some error between the model and the real person.

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