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Virtual People in a Computer World

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Abstract: *Computer space modeling and 3D animation simulation of human body models is an important segment of scientific visualizations and economic Internet presentations of 3D characters and their virtual environment. The usage of 3D scanners offers reliable and precise computer storage of actual shapes and dimensions of various bodies. Employing computer modeling of thus obtained 3D objects, and, for instance, animating characters by key framing or using captured motions for 3D models of human body, it is possible to produce a reliable simulation of virtual human biomechanical models. Construction of computer generated environments and their integration with virtual humans are well developed methods and procedures of applying highly sophisticated information technologies in designing and construction of various working or free-time environments. Real-time virtual humans in virtual world enable electronic media to experiment with virtual TV announcers and actors within computer-generated TV or movie studios, while Internet companies get a valuable tool for developing new methods of utilizing their sites. Financial and manufacturing companies are offered an innovative method of doing global business, promotion and trade via increasingly popular Internet banking.*

Key words: *biomechanics, 3D models of human body, virtual human, virtual environment.*

1. INTRODUCTION

Project Cyber Fashion Group (CFG) by S.Baksa, offers to, based on two photos of an actor, and using sophisticated computer graphics (CG), design and manufacture any type of digital 3D characters and give it virtual life. Cyber personalities developed in this way on a computer screen are practically alive, they can see, hear, talk in real time, sleep, rest and do the impossible, as anything is possible in a virtual CFG cyber world.

The CFG project offers the manufacture of digital identity of real actors, creating their virtual 3D character, such that can present them in a new and sophisticate manned in any media: computer animation, TV, movie and video production, new generation computer games, shopping centers, museums, movie theatres school and university education performances, scientific simulations and visualizations, Internet communities, etc.

The first CFG digital cyber model has been developed for the needs of the Croatian fashion industry, to be used in the first Croatian virtual fashion show, Fig. 1. The

virtual model has been developed using I.Baksa, a real model, as a basis, and contains all the relevant characteristics, except qualitative ones, possible in cyber world only.

Fig. 1. *Frame of a 3D Modeling with Catwalk presentations of First Croatian Virtual Fashion Show*

An accessory software, to be used with computer-textile-garment 3D simulation was made for the purpose of organizing the first Croatian virtual fashion show. It is called *CLOSABA*, and the working version at the moment is *0.4*. The software simulating the garment on the virtual model visualizes the module for the model of the body interacting with the garment module [1]. End-user can survey the animated fashion model on his screen using WWW [2].

2. DESIGNING VIRTUAL 3D MODELS OF CHARACTERS

A virtual model of a real actor can be developed employing hand modeling methods, using conventional anthropometric measuring procedures, or by import of contemporary 3D digitally scanned real models [4].

To design and model a virtual character using hand techniques and at adequately high level of quality, it is necessary to be familiar with anthropometric characteristics of the human body used as a starting point. Software package *ERSABA 4.2.*, developed by the author, was used to determine anthropometric values of the fashion model I.Baksa. The software calculates, using some measured values, twenty-two characteristic anthropometric values, necessary for conventional CG modeling of digital virtual characters, Fig. 2. [3].

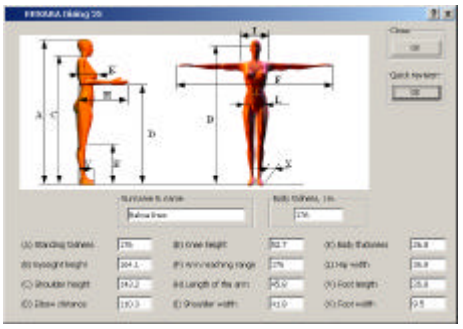


Fig. 2. *On-screen presentation of characteristic antropometric values of a real model, 176 cm tall, in standing posture*

Based on fashion photographs of a real SFG model (P.Anticevic), and using conventional CG techniques, digital virtual character model is designed and constructed. Fig. 3 shows the phases of constructing the segment of the head of the virtual model. The whole of the personal 3D body form is done employing the same principle [4].

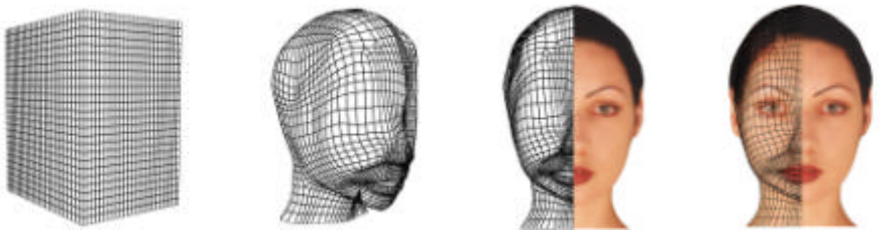
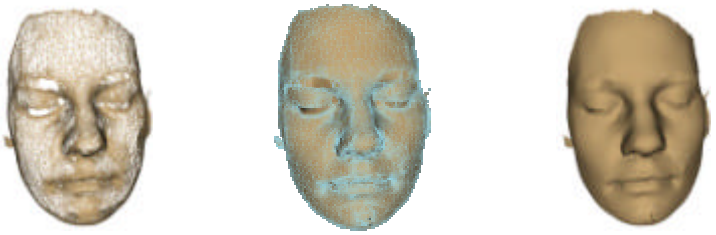


Fig. 3. *Phases in hand modeling of a virtual 3D character's head*

A contactless coordinate-measuring device, so called digital 3D scanner, can be used instead of conventional tape measure and the equipment for defining human body dimensions and volumes. The result of stereoscopic measurements of the body is a 3D cloud of coordinate points, which represent the body measured. These measurements enable easy construction of a digital virtual model. The measuring system employed enhances accuracy and efficiency, compared to conventional methods. The results obtained are not just the object measurements, but also its forms and volumes.

Digital 3D scanners consist of one or more (most modern up to four) digital high-resolution measuring modules, translator units for moving the device, and quite often software solutions for determining 3D characteristics of the objects to be measured. As far as construction and size are concerned, there are small desktop models, ideal for digitizing smaller objects for CAD/CAM industries, development of prototypes, research, animations, special effects, medicine and reverse engineering [5]. Mini models are used to digitize medium size objects, where measuring accuracy and preciseness are important factors. This type of scanners offers best results in medical research, anthropometry, esthetic surgery and artistic manufacturing of portrait sculptures. This type of a 3D scanner is used to digitize the face of the fashion model I.Gomercic. The result is shown in Fig. 4.



a) b) c)

Fig. 4. *Perspective of 3D scanned and triangulated model of a face*

a) in Wireframe,
b) Smooth and Highlights presentation with Edged Face option included and
c) Smooth and Highlights presentation.

Body models obtained using a 3D scanner are ideal for 3D computer animators, ergonomists, anthropologists, physicians, designers, and other professionals who require a precise and reliable 3D model of the body in question. The equipment described can, in some 15 seconds, scan an average adult human body in three dimensions, and record more than 200.000 measuring points defined by coordinates, as seen in Fig. 5. As real actors are an agglomeration of highly diverse variants of shapes and body sizes, the above density of measuring points is adequate to calculate and present on-screen a reliable virtual model. The set of points scanned corresponds with the 3D model body and ideally presents the actor in unit time [6].

Fig. 5. *3D cloud of coordinate points of a virtual model of the actor scanned*

Attributing parameters to unorganized individual coordinate points of a 3D measuring cloud. The results obtained through computerized investigations make possible to construct a surface model out of a dotted 3D cloud, or constructing a characteristic arc, based on spatially coordinate defined points [7]. To construct a digital model based on 3D coordinate measuring cloud, it is necessary to define the characteristics used in a mathematical triangular interpolation [8]. Either surface definition or volume definition can be used as methods in defining these characteristics.

Most researchers, in designing a geometrical model employing reverse engineering, focus upon the procedure of taking a series of surfaces defined by coordinate points of a 3D measuring cloud. This results in a characteristically equal model of the actor, corresponding to a particular dotted cloud, and describing the bodily measures of the character in question. The whole of the virtual model of human body is made on the basis of the knowledge of body volume and cross section, as well as mechanical behavior of the body in dynamic movements.

3. DESIGNING VIRTUAL 3D ENVIRONMENT

To become smaller than the smallest particle of an atom, or bigger than the whole of the universe, to travel through space and time, to past and future, to witness the birth and extinction of galaxies, to peek into the insides of black holes or to travel through human veins and nerves. To build cities and worlds of cathedrals, museums, pyramids, gardens of Eden, or just to observe colors and listen to the heavenly music of paradise, all of this is possible and feasible in a computer-generated virtual environment.

Using real dimensions, human working and living environment, in modeling, together with natural coloration, hues and surface effects in defining surface materials for virtual environment, it is possible to simulate reliably and show virtual interaction of actors and devices used for wok and living, machines and environment around them, which is of special importance in biomechanical, ergonomic and anthropometric scientific virtual visualizations and simulations, as seen in Fig. 6 [9].

Fig. 6. *Perspective Wireframe presentation of a simulation model of a worker at a workplace*

Using artistically free and visionary elements in a virtual environment it is also possible to create non-real, fairyland computer worlds. Computer interaction of 2D photographs of real environment and virtual scenery yields especially interesting results of compositions of virtual people in a computer-generated world.

4. COMPUTER ANIMATION OF VIRTUAL 3D CHARACTERS

To bring a digital character into the life of a virtual world is one of the most demanding and most complex procedures in computer animation. The procedure is called 3D character animation or 3D facial animation. On the level of macro animation, individual extremities of virtual characters are animated, according to the static, dynamic and kinematic actions to be performed, while micro animation includes facial animation.

To animate virtual 3D characters it is necessary to: a) design and develop animated skeleton model, with adequate data basis for movements, b) design and model 3D body model of the character model, to be animated by skeletal movements, and c) perform computer animation of the interaction between the virtual model and its environment [10].

To give successfully an illusion of personality, life, emotions and personal character to virtual 3D actors, employing animation methods and procedures, it is necessary, besides possessing certain amount or artistic sensibility for character animation, to study thoroughly and with understanding the biomechanics of man resting and in movement, as well as movements of other living systems. The theory of men's rest

and movements is mostly based on experiments. They include measurements in assessing postures, speeds, accelerations, forces, moments, etc. in the course of various activities. Experiments are primarily intended to investigate walk as a unique means of movement, various sports, as well as the movements in various professional activities.

The problems of mechanics of movement of living systems are highly complex, especially so for men. Complexity is exhibited in sorting biomechanic samples, as well as in their analysis and movement synthesis, when movability and control of the system investigated (or group of systems) should be defined at the same time.

Conventional approach to the animation of 3D characters includes the animation of key frames. It yields high quality animation results, but the procedures employed are time consuming, which means that production is rather expensive.

More modern and highly popular approach is based on the implementation of the so-called "Motion capture (mocap)" system, Fig. 7 and . These systems detect full macro body movements, as well as full 3D micro facial and hand motions and movements of real human actors. They also digitize real movements into corresponding behavior of virtual characters [11, 12].

Motion capture systems should solve three tasks and should be in accordance with two principally different approaches to data processing. They should be able to detect the movements of real actors, generate various reflections and ideas of virtual characters and translate real recorded movements of real actors to virtual humans in virtual environments. All the motion capture systems are characterized by their ability to store the data recorded for future analysis and processing, while sophisticated versions, so called real-time motion capture systems, enable the translation of the real actor movements recorded, in real-time, onto the computer 3D character, which is often used in live TV virtual performances, as well as in commercial performances and presentations, various shows etc.

Fig. 7. *Gypsy motion capture system*

Fig. 8. *Motion capture system Vicon with a passive reflex markers and high-resolution camcorders*

After macro animation has been done, micro animation, most often consisting of facial animation (fac an) and lip synchronization (lip sync), gives definite characteristics to virtual 3D models. In this way cyber humans can speak, sing and communicate in other ways with other virtual characters or our real world.

Three different face expressions have been selected from facial animation of a virtual 3D model and presented in Fig. 9.

Neutral Smile Anger

Fig. 9. *Characteristic selected frames of virtual character facial animation*

The development of computerized facial animation makes virtual approximations of face muscular contraction possible, using video recording of real human facial expressions [13].

5. VIRTUAL PERFORMANCE, WELCOME TO THE VIRTUAL WORLD

After designing, modeling, animating and rendering has been completed, all the magic of virtual characters in computer worlds can be seen on-screen. Some effort and adequate equipment in computer-based 3D methods of modeling, animation and rendering yield highly realistic scenes, so that it is sometimes difficult to distinguish real from virtual scenes on screen.

There are numerous cases when it is easier to present a movement than to describe it. It is the case with learning to dance (choreography), or with some movements in sports, when efficiency of the demonstration is decisive. Contemporary highly sophisticated real – time motion capture systems are used in these cases, as they offer instantaneous interaction of, for example, professional dancer on stage and virtual dancing character in a computer-generated world. Fig. 10 shows some segments of digital character animation of the first and youngest Croatian baby virtual model, V.Baksa, of the age one week.

Fig. 10. *Segments of virtual performance of digital virtual baby model*

TV houses and studios can, employing real–time motion capture system, instantaneously generate a controlled digital 3D character, in interaction with the real audience present. Virtual facial animation simulation can make some textual data files

famous and accepted TV announcers or actors. Environmental virtual scenery can be transformed easily and with no costs, in a moment. Fig. 11 shows virtual computer-generated environment, which can be used by a virtual TV announcers for news presentation and similar purposes.

Fig. 11. *Presentation of a virtual broadcast studio*

Internet companies based on tele–virtuality applications, which use motion capture systems of virtual character animation, offer their customers multi-user on-line environments. If the customer has a 3D virtual model of his own or some imagined character, there is a possibility of its cyber participation on the WWW.

Development team of the CFG project can offer to the people round the world on-screen virtual try-on of articles of clothing selected for their cyber character, based on their own bodily measures and photographs from their real working and living environment. It comes together with catwalk presentation and in the customer's real sites, where they live and move. An example can be seen in Fig. 12 – a catwalk presentation in a virtual simulation of a customer's living room. These virtual 3D characters can be shown on any type of screen. General public easily identifies with digital cyber actors, creating positive memories, and treating their 3D magic as something new, real and unique. To passionate Internet users, CFG offer realization of a dream – creation of their alter ego, virtual 3D internet-based character and virtual character web sites.

Fig. 12. *CFG concept of virtual try-on, combined with virtual simulation of customer's real living site*

6. FUTURE WORK AND CONCLUSIONS

Using conventional, hand, or more modern, digitally scanned 3D anthropometric human body characteristics, it is possible to construct a digital 3D biomechanical model, with adequate kinematic-dynamic rules of internal skeleton construction movement.

Computer animations of characters and virtual environments are broadly used in entertainment, for practical and educational purposes. Some of the most outstanding areas include advertising, archeology, fine arts, engineering, entertainment, movies, forensics, medicine, multimedia, simulation, scientific simulations and visualizations, space exploration, sports, TV, etc.

Computer animators should possess extensive knowledge of anthropological and biomechanic characteristics of human body, should be experts in design and construction of virtual 3D characters, but should also a feeling for time, mechanical behavior and movements of both living and non-living systems. They should be able to recognize, define and produce the feeling of liveliness and neutrality, so as to be able to give virtual life to their cyber actors.

Integration of digital characters in congress, Internet, video and similar presentations is an ideal solution in the era of audio-visual virtual communications. An advertisement message launched by a cyber actor from a real image or virtual environment is the easiest, cheapest and simplest way of reaching the widest possible audience.

Contemporary internet 3D virtual presentation gives new impetus to production and marketing, generating an interest in the market directed to the corporations that had business sense to recognize on time multimedia possibilities of marketing products and service using the Internet.

Within the Cyber Fashion Group project, employing sophisticated techniques and software tools, it is now possible to design a digital identity by creating a virtual 3D character, based on a real or imagined person. Such a character is an interactive cyber actor, which can speak, move, express feelings and emotions, and be used as a presentation means in all the media. It is also possible to design a virtual 3D character in real interaction with 3D computer-generated environment.

Future developments of the software application *ERSABA 4.2.* will result in improved automatic defining of anthropometric and ergonomic characteristics of biomechanical models and digital actors, as well as in better matching of anatomic and psycho-physiological investigations of human body, based on 3D virtual simulations and analysis of virtual characters.

The purpose of future versions of software accessory *CLOSABA 0.4.* is to develop more advanced computer-based simulation of manufacturing and wearing virtual garment, digitally-oriented fashion production and sale, as well as web-based virtual presentation of fashion engineering.

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