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3D FULL BODY AVATAR APPLICABILITY IN CONSUMER PRODUCTS

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Abstract: *3D full body avatar is the complete, customized, and animated graphical representation of a person in three-dimensions such that it becomes the complete digitalized representation of that person's alter ego. 3D avatars come in many different forms, and they differ in level of details, realism (how closely is the person represented with 3D avatar), and behavior (what moves and mimics the avatar supports). 3D avatars could be created in different ways such as a result of 3D artist creativity, software generators, or using sophisticated 3D scanners. As our society becomes more and more digitalized, the amount of data regarding one person becomes enormous, and what better way of representing that person's data then using the person's avatar? In this paper, we explore different ways of 3D avatar creation and their current use in consumer products. We conclude the paper with discussion on expansion of 3D avatar use in the future.*

Key Words: ***3D full body avatars, 3D avatar creation, 3D avatars application, consumer products***

1. INTRODUCTION

Recent innovations in 3D technology, the tools and processes that allow a product to be visualized, whether on-screen or in physical form, in a three-dimensional format, offer significant benefits. Last decade advances in 3D modeling and depth estimation have created many opportunities for human body scanning, measurement, modeling and creating 3D body avatars. 3D avatars are currently common in video games, virtual worlds and fashion industry. This branch of technology gained popularity mostly due to Microsoft Kinect as one of pioneering products for 3D body avatar creation. Because of the constant growth of the 3D technology the area of its applicability is continuously expanding.

Avatar is a personalized graphical illustration that represents a computer user. Avatar can be represented either in three-dimensional form or in two-dimensional form. 3D avatars are widely applied and their utilization is constantly growing, on other side 2D avatars are mostly used like icons on social networks. 3D avatars can be categorized by their qualities, level of details, how good do they represent a person and their behavior.

System for digitizing the shape of the body and avatars have used in several different industries, that are common with the clothing and fashion industry, which required accurate sizing and capture of full body. Film industry has used the technology to replace real actor with virtual ones (version of Paul Walker has been created to complete Fast and Furious 7, after the actor died part-way through filming [1]). Another industry which is using 3D body scanning is the military industry. Customizing uniforms and equipment for better fitting and less alterations.

Full body avatars are well applicable in medical field and fitness industry. The variety of its usage and difference it could make in future researches is enormous. It could enhance the diagnosis of diseases and improve health of a patient. Periodically visiting a doctor could show what progress patient made in upgrading his life style, measure his BMI (i.e. Body Mass Index) etc.

Creating a 3D avatar of a human body is accomplished by acquiring data which will describe the structure of a 3D human body. This is accomplished with 3D scanning. There are many different methods for capturing the 3D measurements of a physical part and thus, many different types of scanners: 3D Laser Scanning, White Light Scanning, Photogrammetry, Machine Vision, Destructive Slicing, CT or MRI Scanning, Theodolite and Trackers. This list is not meant to be a comprehensive list of available 3D scanning technology, only a brief synopsis of the common technologies used today.

This paper will present different techniques for 3D avatars creation, current usage of 3D avatars, and discuss posibilities for future uses of 3D avatars.

The organization of the paper is as follows. Section 2 gives a brief description of the 3D scanning methods and softwares which are used for creating a 3D avatar. Section 3 describes current usage of 3D avatars in different industry branches. Future implementation and its usage is described in Section 4. Section 5 is conclusion of the paper.

2. CREATION OF 3D AVATAR

3D human representation, 3D avatar, is described with data acquired using 3D scanning. When the required data is gathered, usage of different software allows

manipulation of the avatar. In this section we will discuss and provide a brief description of different techniques for 3D data and software which are most useful for their usage [2].

2.1. 3D Laser Scanning

3D Laser Scanning can be generally categorized into three main categories: laser triangluation, time of flight and phase shift. These laser scanning techniques are typically used independently but can also be used in combination to create a more adaptable scanning system. There are also numerous other laser scanning technologies that are combination of other 3D scanning technologies. Laser triangulation is accomplished by projecting a laser line or point onto object and capturing its reflection with a sensor located at a known distance from the lasers source. Time of flight laser scanners emit a pulse of laser light that is reflected off of the object to be scanned. The resulting reflection is detected with a sensor and the time that elapsed between emission and detection reveals the distance of the object, since the speed of the laser light is precisely known. Phase shift laser scanners work by comparing the phase shift in the reflected laser light to standard phase, which also captured for comparison. This is similar to time of flight detection except the phase of the reflected laser light further refines the distance detection.

2.2. White Light Scanning

White Light Scanning is used to describe a wide range of 3D scanning devices. The basic technique is to project a known pattern of white light and use sensor to capture images of the object with patterns projected on it. In order to capture 3D information, multiple patterns and/or multiple sensor can be used.

2.3. Photogrammetry

Photogrammetry is technology based on standard photography and projective geometry and was originally used to digitize large objects such as buildings, oil rings and warehouse. The principle behind photogrammetry is to take multiple images of objects and manually or automatically reference common points in each photograph [3]. Points can be added automatically or manually to create 3D measurements of the desired elements of the part. Typical example of photogrammetry scanner with multiple cameras [4] is described in Figure 1.

Fig. 1. Typical example of photogrammetry scanner

2.4. Machine Vision

Machine Vision is generally used to detect two dimensional information, such as bar codes, and to sort packages. Machine vision is based on stereo vision, in which a pair of sensors is placed on a known distance from a part, taking two images simultaneously. The resulting images are merged, creating a corresponding points between them. 3D measurement of entire scene is built by calculating the shift in position of the matching points.

2.5. Destructive Slicing

Destructive Slicing is a process in which multiple pictures of an object are taken from a fixed location. Thin slices of the object are removed between each image. The distance to the object is precisely controlled, therefore the scale of each image is known. After slicing all the way throught the object, the images are stacked up in capture software, resulting in a full 3D model of the object.

2.6. MRI scans

MRI scans are obtained by stacking a series of CT [5] or MRI [6] scans on each other in software. This is typically done by precisely controlling the steps in between sectional CT or MRI scan. The resultant data is a 3D model of the object and contains all of its physical measurements. Typical MRI – scaner is presented in Figure 2.

Fig. 2. MRI - scanner

This technology was originally developed in medical field, but is now growing into manufacturing and industrial application as well.

2.7. Theodolite

Theodolite device is a telescope mounted on two rotating axes and is a measuring technique common in surveying applications. The angle to an object is precisely tracked and by taking angular measurements from multiple locations, the distance to the object can be obtained. Modern theodolites are computer controlled to automatically target and measure objects.

2.8. Trackers

Trackers are a class of 3D scanning device that work by tracking the position of a measuring device. Several techniques are used to track the measuring device

including laser, magnetic position, optical position and acoustic position. The various methods all track the position of the measurement device, recording the position each time a measurement is taken either by touching the object or by using non-contact scanning technology.

2.9. Software for 3D content creation

With different 3D scanning techniques different data is gathered. Acquired data is further managed and organized by appropriate software. All software have the same goal, to build, make and represent a 3D model of an object. Softwares mostly represent a 3D model like a point cloud (set of different particles and 3D points of an object) or/and a mesh (connected set of polygons, usually triangles). Most popular and most known 3D software are Blender, SketchUp, SolidWorks, AutoCAD, Maya, Photoscan etc. [7].

Person who is developing 3D avatars is a 3D artist. 3D artist profesiion is very unique, mainly in it's combination of artistry and technology. Someone who is just a great artist can't do it without the technological background while at same time it doesn't matter how much technical knowledge you have if you have no artistic ability or talent. A 3D artist is unique in the combination of the necessary skill and flare needed to make a stunning 3D rendering and animation. Tasks of 3D artist can be broken into a few: modeling, texturing, lighting, animating and compositing. Modeling is creation of 3D mesh to form shapes. Texturing is application of surfaces to the 3D mesh to simulate real materials. Lighting is the placing of 3D light sources within a scene to simulate real life. Animation is addition of movement within a scene. Compositing is the blending of real life video or photography with the 3D scene. At the end of all this tasks final result is a 3D avatar.

Creating 3D avatars is also possible using 3D avatar software generators. These kind of softwares have tools which let you chose what kind of attributes will your generated 3D avatar have. Shape of body, nose, mouth etc. What kind of clothes will it wear.

3. CURRENT USAGE OF 3D AVATARS

3D technology is advancing every day. Implementation of it is constantly growing and because of that it is hard to keep track what is developed. When a 3D avatar is mentioned, people first think of games and other kind of entertainment. Entertainment is one of the most developed branches of 3D avatar usage, but not the most needed and helpful. This part of paper will in detail describe main industry branches which utilize 3D avatars, how they utilize them and what for.

3.1. Medicine

Displaying fully scanned human body in computer, doesn't allow you just to manage or change it, it also allows you to inspect it to the tiniest details. Such idea has persuaded engineers to start thinking and implement 3D body avatars in medicine field. Expending this branch of technology treating patients and diagnosing diseases is much more faster.Researches from University of Queensland have invented a system, VECTRA Whole Body 360 [8], which is thought to be a game changer in fight against skin cancer, using 3D avatars of human body. System is designed so that the patient stands within a scaffold supporting 46 cameras, each of which takes an image at the same time. After the high resolution images are taken, Figure 3, a computer software stitches all the images together and creates a 3D representation of patient.

Fig. 3. Mr Glen Wimberley and Professor H. Peter Soyer using the VECTRA Whole Body 360

A separate camera can be used to focus on dermoscopic injuries of patient. In this way dermatologist can scan their patients and compare previous scans. This way if a mole starts to grow, doctors can see the progress and call their patients for further treatmant.

3.2. Fitness

Fitness is another branch of 3D body scanning technology which is rapidly growing. People are active, not just because it is healthy, also because they enjoy their well shaped and good looking bodies. Constant scanning of a human body time to time can show progress in its forming and shaping. Currently there are few companies which are developing consumer products in this area.

Company Naked [9] has developed a mirror which has built in 3D depth sensors, Figure 4, Intel RealSense Technology.

Fig. 4. Naked fit set up

Beside the mirror there is a rotating platform on which the customer stands during scanning, this also allows the setup to measure users weight. User can scan himself whenever he wants and all its data is transferred to his smart phone. This way he can see his 3D avatar, inspect it and compare with previous scans. The setup keeps measure of all users most important measurements and shows changes overtime, allowing to set required assessments and see on which parts of body user should focus.

3.3. Education

Education is the process of facilitating learning, or the acquisition of knowledge, skills, values, beliefs, and habits. Education is one of the most important things in a life of a human. With expansion of technology its use has crossed to education as well. Education and knowledge are very important in every aspect of life, but to become more experienced and skillful in something humans need practice.

Orlando-based company named Vcom3D [10], is leader in providing impresive games and blended reality learning to train critical human interaction skills, Figure 5. Vcom3D [10] developed authentic content using research-based behavioral and physiological models, engage the learner in immersive game play, assess performance in realistic simulations, and provide a collaborative Social Media Framework that enables continuous improvement of learning outcomes.

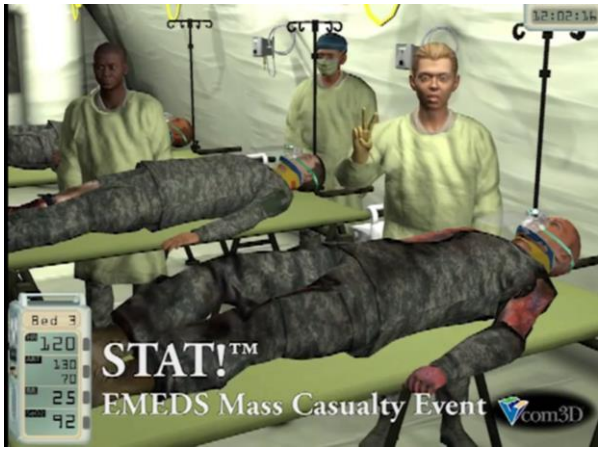

Fig. 5. Vcom3D STAT! Trauma Team Trainer – educational game screen shot

STAT is series of game based simulations which challenge critical thinking skills of medical practitioners from novice to highly skilled and it is one of the most popular educational game developed by this company. These serious games feature detailed virtual patient physiology, appearance and behaviors to support treatment of trauma throughout the care. STAT provides an infinite number of outcomes and the company claims that fifteen minutes of gameplay can translate into many hours of training resulting in higher improved outcomes and higher return of investment. Beside medicine game based software, company developed mobile application for sign-language learning. Sign4me [11] has built in 3D avatar of a person which provides sign language instructions. Avatars can be zoomed in/out and rotated to give best vantage point for every sign. The database contains more than 11,500 sign words which can be interpreted like single word or like a whole sentence. Beside these application, company has produced SignSmith [12] signing avatar authoring tool , for the creation of 3D avatar animations specifically focused on sign language gestures and translation. It has been used for the creation of sign language accompaniment for educational content. The suite consists of software to facilitate in the creating of signing gestures and has support for the use of motion capture of interpreters. Note that this is an authoring system and does not seem to be intended for real-time translation.

3.4. Fashion

Most of the clothes bought online are returned to the seller, frequently because they are wrong size. This costs sellers millions of dollars in extra shipping costs and warehouse fees, putting a dent into their profits. It also frustrates many of those buying the clothes.

Recent advances in consumer depth sensor have created many opportunities for human body measurement and modeling. Estimation of 3D body shape is particularly useful for fashion e-commerce applications such as virtual try-on fit personalization. This branch of 3D scanning and avatars is maybe the most developed because of its economical impact.

Fitnect [13] has made a revolutionary advance in virtual try-on fit of clothes, Figure 6. It is an interactive virtual fitting room application built on the most advanced technologies: augmented reality, cloth physics and full body motion capture. Customer can select garments from the menu without trying them out at all. Watch himself onscreen with a 3D copy of the selected cloth. Customer can control the program by pushing virtual buttons right in the air.

Fig. 6. Person using Fitnect to try out clothes

Bodi.me [14] is one of startup companies which saw an opportunity in this technology. Their solutions makes use of simple inexpensive motion-capture devices like those found in video-gaming hardware. These take 35 precise body measurements and create a visual avatar, which is then stored online. This data is afterwards made

available to sellers to help them suggest the right size of clothing.

Latest softwares of companies which make use of the cameras and great computing power inside the latest tablets and smartphones will soon be the pominent way we will scan our bodies. All of this will be done in comfort of our home.

3.5. Entertainment

The entertainment industry utilizes 3D technology in some of the most exciting and experimental ways that are helping the technology to evolve. Commercials, movies, video games and even theater performances have benefits from 3D scanning solutions.

One of the most popular video games producers which is utilizing 3D scanning technology is EA Sports [15]. They have used laser scanning technology in their most popular franchise, FIFA 15, to capture both information about stadiums and the faces of players. The technique is referred to as creating "character doubles". The use of character doubles created through 3D scanning is incredibly widespread both in film and in video games. It allows for the quick creation of replicas of famous historic individuals. Since modeling from a scan is significantly faster and more accurate than modeling from photographs, more detail can be put into the model, or a higher variety of characters can be created for the game or film. 3D scanning also allows for the creation of more authentic facial expressions per individual person.

For past few years, avatars have been used in networked 3D virtual enviroments by gaming industries. Networked virtual enviroments allow users to interact over Internet in real time and get feeling of virtual telepresence.

3D avatars are already widely spread through entertainment business, but their usage is constantly growing. Every day we can see new ideas which are not currently feasible, but surely they will become in a few years.

4. FUTURE USES OF AVATARS

Avatar usage is rising every day. It is impossible to imagine a game or a movie which is not implementing a 3D technology. Near future will bring us more innovative ideas and implementations. Direction in which it will evolve is unpredictable.

3D avatars are currently applied in medical area of science as far as technology allows. One of the direction it should expand is certainly the whole inner representation of human body. This kind of 3D avatar would show patients detailed health status up to a cellular level. Doctors could see every blood vessel and its inner state, if it is clogged or torn. Also, this would mean that doctors would be able to see every organ of patient and exam them individually. Physiotherapist could use 3D scans as a guide how to treat injured spots on a patient. Which move to use and from which side to start. Main reason why this is not yet done is because of current hardware technology. There is no such 3D scanner which would scan a human body inside out. If this would be done the possibilities are only imaginable.

Sport section has a big potential for implementing 3D avatars. On every bigger sport event producers show previously played action or move. Currently comentators and sport analytics are drawing on screen and explain how should an action take place or be played, what a player did wrong or where the ball should have gone. It would be pretty amazing if they could do it with players 3D avatar and their animations.

Most persons hate waiting in a line. This is one of the problems that customers need to deal with when buying clothes. Waiting lines for fitting room in a store can be very long and very frustrating. Fashion stores try to reduce this problem by allowing customers to return clothes in a pre-specified period of time. This problem would be solved if customers could see how they look in clothes in the store, without underssing. There are developments for this matter, but is far away from massive production and usage. One of the futuristic ideas is to enable customers to design their own clothes according to their measurements and send it in sewing. Also one of idea is that in future users could scan their whole room with their phone or tablet. After that they would transfer scanned room on furniture shops website where they could try out shops furniture in their scanned room. Replace their old chair with a new one, see how it fits inside the room. Show their avatars with animation how they sit in that new chair

Previously mentioned ideas are some of the many which are possible to achive with future technologies. It will not only make easier for people to do daily chores, it will also make possible to save more lives.

5. CONCLUSION

This paper describes 3D avatars, their utilization, creation and possible future implementation. Paper described their utilization, creation and possible future implementation. At the begining of this paper it is described how a 3D avatar is made. In this period of time it is fairly easy to make a 3D model of a human, but the individual usage of it is yet developing and expanding. In the paper are also described techniques which are currently used for scanning people and making 3D avatars. Development of better 3D scanners with better quality will result with better and more qualitet 3D avatars. Recent advances in scanning technology have enabled widespread acquisition of 3D models from human subjects. In order to use such 3D models for dynamic animation as 3D characters in virtual characters, such 3D static models must be properly rigged. The rigging and skinning attributes can then be transferred to reshaped body scan to produce the virtual avatar. This paper has presented some ideas for future usage of 3D avatars. Many industries are currently using 3D avatars in their business, but much more are thinking of implementing it in them. In future implementation of 3D avatars will be enormous, it will infulence many branches of live and it will be unavoidable. Their immplementation is constantly growing and it will become more and more common part of our lives.

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