As a dentist, they perform their cleaning operation virtually: 3D visualization for a dental cleaning with Oculus Rift glasses and display of Dicom image data.

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Abstract

The paper, titled "How Dentists Perform Their dental cleaning work virtually: 3D visualization tion for dental cleaning with Oculus Rift glasses and display of Dicom image data," authored by Mohamad Wael Kheshfeh and Erik Raschke, describes a technique for cleaning teeth with the aid of virtual reality technology. The authors' paper inspired a study of the potential advantages and practical applications of this method. The results suggest that simulation of dental procedures in a virtual environment can help minimize errors in performing the procedures in real life.

Keywords

Visualize models, Dicom images, Unity 3d illustration mixture, Virtuell Reality

1 Introduction

This method of 3D visualization of an operation is a modern method of visualization and virtual execution of a sensitive operation in various fields such as the field of medicine. This ranges from the field of engineering (e.g. visualization of a tool or manufacturing of a vehicle part) to the natural science operations (e.g. conducting an experiment in the laboratory).

As the field of minimally invasive surgery continues to evolve, surgeons are losing direct visual access to the surgical site.

Figure 1: 3D visualization of human hands

They must instead rely on camera images from an endoscope inserted into the body. In traditional surgical procedures, these camera images are displayed on a monitor, adding an additional workload for the surgeon as they must monitor, process, and mentally map the image to the body in front of them. Virtuall Reality (VR) has the potential to merge these and other sources of information, reducing the workload on the surgeon. It can also potentially shorten the duration of the procedure and anesthesia [1].

In this project Smile PNT (doing 3D visualization as Smile PNT for a dental cleaning with Oculus Rift), we have improved the performance of an existing idea to vary visualization of dental applications while generating specific models.

1.1 Outline

The structure of the paper is as follows: In Section 1, we give a general overview of the project's Smile PNT design concept. Section 2 explains the research design and methods used, with a focus on the general approach rather than specific code. In Section 3, we provide three examples to showcase the outcomes of our research. Section 4 compares our findings with those of other tools to determine the best results. Finally, the paper concludes with our final thoughts and suggestions for future enhancements.

1.2 The medical Significance

Plaque, also known as biofilm, forms in the mouth on the teeth after one to two days. This biofilm is composed of billions of bacteria that have an active metabolism. During this process, the bacteria consume isolated carbohydrates and release acids and toxins. These aggressive substances can cause dental damage such as tooth decay and gum inflammation leading to bone loss. Many individuals, even with good oral hygiene, are not able to reach all the spaces and crevices in the mouth to remove these bacteria.

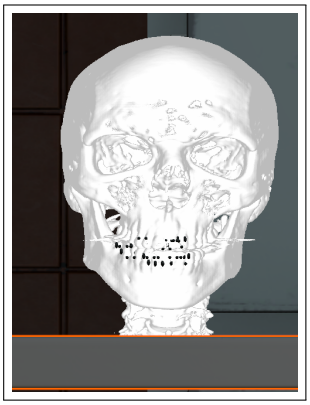

Figure 2: 3d-Viualization a Human Skulls with Unity-tool

Regular and thorough cleaning of the teeth is particularly important for older patients as the gums recede, exposing more tooth surface to plaque and bacteria. Additionally, as people age, dexterity may decrease, reducing the quality of daily brushing technique. Furthermore, many people experience changes in metabolism, such as chronic illnesses or medication, that make them more susceptible to tooth decay and periodontitis [2].

In the dental field, AR is particularly useful in such cases to support surgical procedures, especially in the area of surgical visualization. By combining different data sets (camera images, X-ray images, previous model data from a Dicom/CT scan, etc.), information that would otherwise be separate can be displayed correctly and simultaneously in the dentist's field of view.

DICOM - Digital Imaging and Communications in Medicine

DICOM stands for Digital Imaging and Communications in Medicine. It is a standard file format used for storing and transmitting medical images, such as X-rays, CT scans, MRI scans, and ultrasound images, among others. DICOM images are digital images that are created using medical imaging equipment and saved in the DICOM format. It images are designed to be compatible with a wide range of medical imaging equipment and software, making it easier for healthcare providers to share and view medical images across different systems. DICOM images typically include both image data and metadata, such as patient information, exam type, and imaging parameters. One of the key features of DICOM images is their ability to store large amounts of image data, including high-resolution images and 3D images. DICOM images can also be compressed to reduce file size without compromising image quality. DICOM images are often used in medical settings to diagnose and treat a wide range of conditions. They allow healthcare providers to visualize the internal structures of the body and identify abnormalities or injuries. DICOM images can also be used for treatment planning and monitoring, as well as for research purposes. general, DICOM images are a critical component of modern medical imaging, providing healthcare providers with a powerful tool for diagnosing and treating a wide range of conditions.

1.3 The technical Background

Virtual reality serves as a bridge between the computer system and humans by simulating the world on a computer, creating a human-computer interface that can be designed to be intuitive and natural. For example, using a steering wheel and pedals in a car racing game instead of a mouse and keyboard creates a more realistic virtual reality experience, making the operation of the virtual car and navigation through the virtual world more similar to real life. A perfect virtual reality can be thought of as an ideal user interface, allowing users to interact with the computer as if they were in the real world. The study of virtual reality is a way of exploring new forms of human-computer interaction by working towards a vision of an ideal virtual reality. Even if this vision is never fully achieved, it can still lead to the development of new and valuable

ideas and user interfaces that make it easier for people to interact with computer systems [3].

MagicaVoxel

MagicaVoxel is a free 3D modeling software program that allows users to create voxel-based models. Voxel-based modeling involves using small cubes or voxels to create 3D models, which gives the models a pixelated, blocky appearance. MagicaVoxel is specifically designed for creating voxel art, which is a type of digital art that uses voxels to create pixelated, 3D images. It provides users with a wide range of tools and features for creating voxel art, including a range of brush tools for creating and sculpting voxels, a color palette for choosing colors, and the ability to apply textures to models. It also has tools for creating animations and rendering models. One of the key features of MagicaVoxel is its ease of use. The software is designed to be user-friendly and intuitive, with a simple interface that is easy to navigate. This makes it a popular choice for beginners who are new to 3D modeling or voxel art. MagicaVoxel is also highly customizable, with a range of options for adjusting settings and preferences to suit the user's needs. It is available for Windows and Mac operating systems, and there are also mobile versions available for iOS and Android devices. Overall, MagicaVoxel is a powerful and versatile tool for creating voxel art, with a wide range of features and a user-friendly interface that makes it accessible to beginners and experienced users alike.

1.4 Related Work

This project Smile PNT builds on existing models, making it easier to implement and achieving the desired result more accurately. The target forms are compatible with Oculus glasses and various versions of Unity, and provide several options for variations of Dicom images and model thresholds. However, it is not possible to create Dicom images without predefined sets or random data. The project continues until the teeth are fully cleaned, and in case of failure, the implementation is interrupted and repeated. The visualization strategy used is virtual reality, where computer-generated information or virtual objects are added by superimposition/overlay. The results are compared using the Dicom model of the human skull, which is used as an explanatory model in reality but resembles the patient's skull in our project because it is a Dicom image of the patient. The models installed from the asset store are the basis for our project, but are also used for other applications. For more information and related models, we recommend consulting the list of their works.

2 Research Design & Methods

The basic approach to performing an dental operation that would be done in real life by a dentist is to gradually achieve the goal while taking into account the accuracy and safety of the patient. This is because it is often difficult to predict the outcome of an operation that depends on the actions of both the dentist and the patient. It would be much easier to first test if the operation is likely to be successful and show the patient what the final result will look like. Therefore, our project Smile PNT focuses on various ways of performing steps and using tools to achieve the goal with higher quality and comfort. At each step of the operation, we pay attention to the measurements displayed on the screen, with a focus on comfort. After each step, the results are recorded, and various target shapes are evaluated and compared to the skull. If the error is small enough, the change is accepted and the next step is taken. In order to achieve the final target shape, all debris must be removed and cleaned with water, resulting in a final quality that is similar to perfect teeth cleaning.

3 EXAMPLE RESULTS

In the following, we would like to present some results provided by our program. All the target shapes used were drawn using the Paint program, then extracted as 1000x1000 bitmap files and later, with the help of an image to binary converter tool [4], saved as binary .txt files. This is a simple process for any user of our program to use customized shapes. For the starting datasets that are to be manipulated, we used the same ones that were used in Unity-Asset packages .
[4] [5] [1]

3.1 Example 1: Representation of the human physique through an avatar

Two examples of human avatar bodies are presented here. The images shown were created by taking images of two patients.

An avatar is a computer representation of real images of people in a computer-generated 3D world, mainly used on the Unity interface.

Figure 3: Examples of visualization of the avatar body

3.2 Example 2: Construction of the dental instrument with the Magicavoxsel tools.

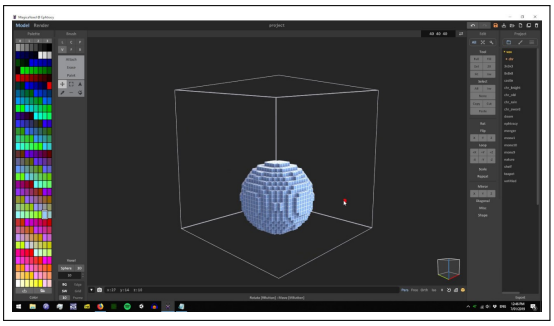

Figure 4: MagicaVoxel example module

Using magicavoxel, we created the instruments in more detail and stitched them together in the Unity Hub interface. Inclusive, by combining a precise mechanical design with high-quality projection technology, it was possible to realize a 3D system that enables intuitive visual analysis of high-resolution scientific data in three-dimensional space. Since ergonomic factors such as sufficient luminance and homogeneity, high contrast, excellent channel separation of the stereo projection and small distances between the individual screens have been consistently taken into account.

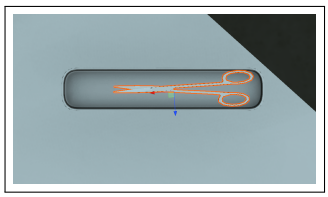

Figure 5: Examples of visualization of dental cones and surgical skierries

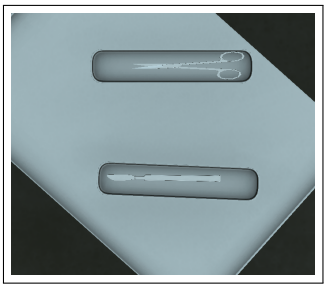

Figure 6: Examples of visualization of dental skierries and surgical knife

Figure 7: Examples of visualization of dental cones, surgical light and water cones

3.3 Example 3: Unity-Dicom tool

DICOM Loader in Human Skulls is a Unity-based asset that facilitates the loading and display of DICOM images and files. This asset enables easy development of DICOM-related images in skulls. In addition, the tool can create axial, coronal and sagittal MPR images from CT, MR or DICOM files that you select.

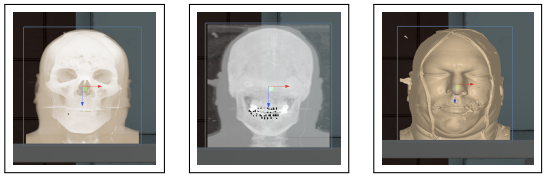

Figure 8: Examples of visualization of the avatar body

4 Virtual Reality in the dental Education

Virtual teaching has gained popularity in Australian universities, especially in dentistry where it has significantly enhanced the quality of education. In the past, dental students learned by working on real patients, but this approach had limitations, such as the unavailability of patients and the potential for serious mistakes. However, virtual simulations offer a safe and risk-free environment for students to learn and practice their skills. For instance, the Virtual Reality Dental Simulation program developed by the University of Adelaide allows students to practice dental procedures using virtual teeth and gums, virtual tools, and instruments. They can receive immediate feedback on their performance in a realistic virtual environment. Virtual dental education offers numerous benefits, including personalized learning, the ability to repeat procedures as many times as needed, and a reduced risk of mistakes with no harm to real patients. It also enables educators to monitor students' progress closely and provide personalized feedback to improve their skills. Moreover, virtual dental education has been found to enhance the quality of dental care. A study conducted by the University of Sydney revealed that dental students who received virtual training were more confident and competent in performing dental procedures than those who received traditional training. Inclusive, virtual dental education is a successful and innovative way to enhance the quality of dental education and care in Australia. As technology advances, virtual simulations will continue to play a vital role in dental education[6].

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