3D ENT (Ear, Nose and Throat) Modelling and Implementation into Mixed Reality Environment

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Abstract. Otolaryngology is a medical science that focuses on the problems of the ears, nose and throat. Otolaryngologists in their roles are people who have been trained in medicine and surgery in the ENT department. To get maximum results, a good practice is needed from the beginning to the end of the examination. 3D digital model is one of the services to facilitate pupils in choosing the desired education method. 3D Object is a depiction of an object that is equipped with a perception of space. 3D Object is an object that is designed and drawn the length, width, and height (x, y, z axis) of the object so that it looks more real. The result showed that each organ was detected by displaying a 3-dimensional object in accordance with the original object. Mixed reality is a technique to merge a virtual simulation and real-world environment. 3D digital model in mixed reality technology is one way to make the ENT learning more attractive. With the existence of a 3D digital models in mixed reality environment, it will be easier for pupils and the surgeons to perform a maximum organ learning.

1. Introduction

ENT is a branch of medicine that specializes in the diagnosis and treatment of ears, nose, throat and head and neck disorders. Otolaryngologists in their roles are people who have been trained in medicine and surgery in the ENT section as well as the parts related to the head and neck [1]. Like other medical fields, there are various complex organs in the ENT area. To be able to establish a diagnosis of a disease or disorder in ENT, anamnesis ability and skills are needed to examine these organs. This ability is part of a physical examination if there are complaints or symptoms related to the head and neck. To master these abilities and skills, regular training is needed. One of them uses models and simulations.

The digital era is increasingly demanding renewal so that existing models cannot just always be available, but also practical, mobile, and interactive. This development requires developers to be able to model mannequins and 2D sketches into 3D models that can be implemented into various virtual media such mixed reality. In its development, there are various methods that can be used for 3D modeling, this research will further use the method of image-based modeling and 3D box modeling.
Mixed reality, a mix of reality and virtual reality, refers to the wide domain of the continuous transition between the two extreme ends, physical reality to virtual reality, which is shown in the following figure [3]. The development of digital simulation demand the developer to create the simulation for otolaryngology. With Microsoft Hololens device, the possibility to create mixed reality simulation become possible.

Moreover, a carefully set up mixed reality environment consisting of various fitting learning elements with proper strategies and decorations will be important for the students to enjoy the immersive experience as well as acquire the knowledge[6]. The overarching aim of an appropriate design in a mixed reality system would be to match the users’ characters (e.g., age, pre-existing knowledge). In this case, the mixed reality learning system from Shanghai Jiao Tong University was developed with a Data Analysis Center, which collects and analyzes the process data from teaching and learning in the log files of web-servers to enable the further development of the learning system, including students browsing online courses and querying course materials [2].

2. Methodology
The methodology of this study consists of several phases, i.e. data collecting, 3D modelling and mixed reality setting. It is shown in the Figure 1.

Figure 1. Methodology of the application.

2.1. Data collection
The first stage of this research is data collecting. In this stage, two kinds of data were collected. The first type of data is 2D Sketch from ENT organs and the other type is ENT anatomy’s mannequin. Both data set to be the guide to construct the 3D model of ENT. Images collection can determine the layout of the model to be designed in 3D modelling. In Figure 2, it can be seen some photos that have been made as references in order to make the 3D model of the ENT.
Figure 2. 2D sketch of ENT anatomy.
(Essential of Otorhinolaryngology, Mansoura Univ. Egypt, 2007)

2.2. 3D modelling
The 2D Sketch that have been collected will be proceeding to be 3D models using Box Modelling method and Image-based modelling method. There are three basic primitives or fundamental ways to create a 3D shape: points, curves, and polygons. Points are the simplest primitive; a 3D shape can be composed of a large amount of points to cover the whole 3D surface, where each point can be represented by a 3D vertex. A more practical and compact way of representing 3D shapes is using curves, which can be approximated by lines or points. Curves are used to describe complex 3D surfaces.

2.2.1. Box modelling
Box modelling is one of 3D modelling technique that started from primitive mesh (cube or sphere). Using extrude, scale, and, rotation (face, edge, and vertex) tools, the primitive object can be modified to be a very complex object.

Figure 3. Box modelling method. (http://google.com)

2.2.2. Image based modelling
Image based 3D modelling is another method that to begin the modelling process, the artist needs a reference 2D sketch. In terms of making a 3D model various angle of the original object, at least front and side angle. An example of modelling a 3D face model in frame 4, require at least front and side angle.

Figure 4. Image based 3D modelling method.

2.3. Model enchanting
Model Enchanting is the final steps in making a model. In this step we calculate the best surface subdivision that suit the model properly. A high surface subdivision high be look more real and smooth,
but vertices reduction is useful for rendering process, making the object become low poly and simplify the UV mapping on the object.

2.3.1. Materializing.
3D model of the anatomy should be given appropriate materials and textures. The common material are bones, organs, and vessels. Material contains parameters to determine how light interacts with the surface of the model, so the material is able to provide the level of staining that has quite good gradation and can be arranged as desired.

2.3.2. Texturing.
In terms of running in a real time rendering in mixed reality, an object should be performing a real impression. With texture, we can colorize the surface of the object to accomplish our objective. The technique to create texture is UV mapping. With UV mapping, we can tell the software to place textures at an exact location. When we create a UV map, the computer has all the instructions to place the textures where the artist wants on a face. UV map images can be seen in Figure 6.

UV texturing permits polygons that make up a 3D object to be painted with color from an image. The image is called a UV texture map, but it's just an ordinary image. The UV mapping process involves assigning pixels in the image to surface mappings on the polygon. UV is the alternative to XY. It only maps into a texture space rather than into the geometric space of the object. However, the rendering computation using the UV texture coordinates can determine the painting process of the three-dimensional surfaces.

![Figure 5. UV map images of ear, nose, and throat.](image)

2.4. Mix reality setting
The mixed reality technique can be developed in Unity for the visual and Visual Studio application to compose the codes. An additional tool named Mixed Reality Toolkit provide us a lot of function that can be used to create a mixed reality application. Started with spatial mapping to recognize the surround and the following steps are to determine the 3D Model placement and interactions that user can do with it.

3. Result and discussion
Figure 7 show the result of the 3D modelling which is the output from the method used.
And the implementation of the 3D model in mixed reality environment and a user is using Microsoft Hololens shown in Figure 8.

4. Conclusions
Based on the previous discussion and evaluation, it can be concluded as follows:

- The application has been demonstrated to be able to represent an ENT 3D Model in digital reconstruction. The result of the reconstruction process follows the stages of 3D modeling based on Precision Match methods.
- The 3D Model of ENT helps the students of science to have more alternative to learn about ENT anatomy.
- Mixed Reality Technique makes the experience with the 3D model more immersive.

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