USE OF 3D IMAGING FOR TEACHING ANATOMY IN MEDICAL EDUCATION AND THE DEVELOPMENT OF THE FIRST BULGARIAN 3D ANATOMY ATLAS

Christov, H.[1], N. Dimitrov[1], D. Atanasova[1], N. Tomov[1], D. Sivrev[1], H. Milcheva[2], I. Popov[2], M. Petrova[2], K. Mollova[2], A. Uzunova[2], P. Teneva[2], I. Dobreva[2], K. Kichukova[2], M. Dimova[2], P. Krumova[2], R. Sherletova[2], A. Georgieva[1], J. Stoyanov[1], I. Ivanova[1], S. Hamza[1], I. Valkova[1]

[1]Department of Anatomy, Faculty of Medicine, Stara Zagora, Bulgaria
[2]College of Medicine, Stara Zagora, Bulgaria

Abstract

Understanding certain parts of anatomy is often found difficult for students due to the complexity of the material and the lack or insufficiency of practical lessons. Even with real anatomical models and dissections a big portion of the theoretical material cannot be seen in real life. In the century of computer technologies computer generated images can be solve many of the problems in teaching and learning anatomy for both students and lecturers.

The goal of this project is to create interactive 3d software that will ease and simplify the learning process and provide a better and more accurate view over human anatomy. Although many 3D viewers exist we want to create an interactive and flexible imaging source, coordinated with the needs and preferences of students, combined with real-life photos and references.

The software will be created by students under the instructions and monition of the lecturers from the department of anatomy. The environment will be based on Unity, which is a free cross-platform game engine. This will allow us to easily create an application that will run on multiple platforms both desktop and mobile. The 3D models will be created entirely from scratch on a software, called Autodesk 3Ds Max, using real photographical references from the department of anatomy in the Faculty of Medicine of Trakia university. The back-end coding will be realized using C# programming language.

The first realease of the application will contain the human skeletal system with she skeleton as a whole as well as all the bones seperately. Future upgrades will include all other systems of human anatomy as well as topographical features.

Introduction

Understanding anatomy can sometimes be found difficult for students due to the complexity of the material. One of the biggest problems they are facing is understanding the way all the elements in human anatomy correlate to each other. This is because in real life the organs and systems are not isolated. They are all in one place, they are linked, and are in the most difficult topographical relations.

Even with real anatomical models and dissections a big portion of the theoretical material cannot be seen in real life. In the century of computer technologies computer generated

images can solve many of the problems in teaching and learning anatomy for both students and lecturers.

Three dimensional computer graphics have first been created in the early 1970s and have passed a long way of development up until now. It wasn't until not so long ago that computer generated images were first used to visualize anatomical models. Nowadays several 3D viewers exist that are really handy for students all over the world. 3D modelling and software development are now as easily accessible as never before.

Aim

The goal of this project is to create an interactive 3d software that will ease and simplify the learning process and provide a better and more accurate view over human anatomy suitable with the educational curriculum in Bulgaria. Although many 3D viewers exist we want to create an interactive and flexible imaging source, coordinated with the needs and preferences of students. With better detailed and hopefully photorealistic models, combined with real-life photos and references it will be the needed addition to the traditional atlases of human anatomy.

The target group of this application as expected is going to be the students from medical universities, not only medical students but also nurses, paramedics etc. Apart from the students it will be also targeted to the lecturers. 3D anatomy viewers are able to fill a gap between the students and lecturers for certain parts of anatomy that cannot be shown or easily explained. It will be used in interactive lectures including an interactive screen controlled by the lecturer as the position of the models can easily be changed on demand.

Material and methods

Apart from the goal and the target group of the project, the most important part that must be considered are the materials and methods that are going to be used. The resources are compliant to the final goal that is pursued. Several characteristics of the application need to be considered:

- It must be cross-platform, meaning it should easily run on several different devices using different operating systems, including the most common ones(Windows Desktop, Windows mobile, Android, Mac OS, iOS etc.);
- It must include detailed and realistically textured 3D models of all anatomical structures;
- It must be coded in a language that will allow it to be done as easy and light as possible, and provide a possibility for easy editing;

There are plenty of choices for an engine that satisfies the needs of this project. Mainly we have two – Unreal Engine and Unity.

Unreal Engine is a 3D game engine that is widely used through the world of electronic game development. Since its release in 1998 it has been one of the most used and advanced engines as it has been awarded by Guinness World Records as "the most successful video

game engine. As of March 2, 2015, Unreal Engine 4 is free to use along with all future updates. Since then it's widely used for the development of many 3D viewing platforms including interior, exterior, furniture design and many more.

Unity on the other hand is a cross-platform game engine which is also used for games and simulations for most platforms available. It is a bit lighter and easier to use and it supports GUI (Graphic User Interface) creator. The main advantage is that it is cross-platform. 3D anatomy atlases have previously been created using Unity (fig. 1). Both engines support C# and C++ languages, one of which is going to be used for the development.

The hardest and most time-consuming part is the development of the 3D models. They are going to modelled using a software called Autodesk 3D studio max (fig. 2) with the help of two other programs – ZBrush and Autodesk Mudbox. The work on the models has begun with the upper limb. Three bones are made – humerus, radius and ulna - to test the method and the appearance, using mobile 3D model viewers. The only concern is the high-poly design which might make the application a bit heavier and demanding for weaker devices.

High-poly is a modeling method used to create higher detailed models. Three dimensional models are structured by a so-called wireframe. Wireframe is the "skeleton" of each model. It is created by specifying each edge where two mathematically continuous surfaces meet. In 3D modelling the three main units building a model are vertex, edge and polygon. They are analogues to point, line and plane in solid geometry. For instance a cube consists of six walls or faces(polygons), twelve edges and 8 vertices. Each two faces meet in one edge and three faces as well as three edges meet in one vertex. This means that every 3D model can be described as a solid three dimensional polyhedron with flat polygonal surfaces. Unlike traditional mathematical solids it consists of thousands, sometimes millions of faces.

Such is the case with high-poly models. For instance the bones that are created now have the following characteristics:

- Humerus – 6 646 polygons (fig. 3)
- Radius – 5 148 polygons (fig. 4)
- Ulna – 16 598 polygons (fig. 5)

This can create some difficulties in rendering and loading the models in real time. When they are loaded separately and are viewed one at a time, there is not going to be any problem for the device. But when the whole body with all systems is viewed, it may result in slower times. This is a problem of optimization that is going to be solved after the release of the application.

The Department of Anatomy in the Medical Faculty Stara Zagora already has a photographic studio equipped for the purpose of photographing anatomy props. It is going to be used for photographing reference images and textures for easier and more realistic modelling.

The first release will only include the human skeletal system with the skeleton as a whole as well as all the bones separately including the skull. After the release of a stable and working application further updates will follow to include all other systems as well as topographical features.

Conclusion

3D graphics can be used in many aspects of today's life as well as in teaching and learning all different subjects. It can make anatomy more understandable, easier to learn, easier to teach and a bit more entertaining.

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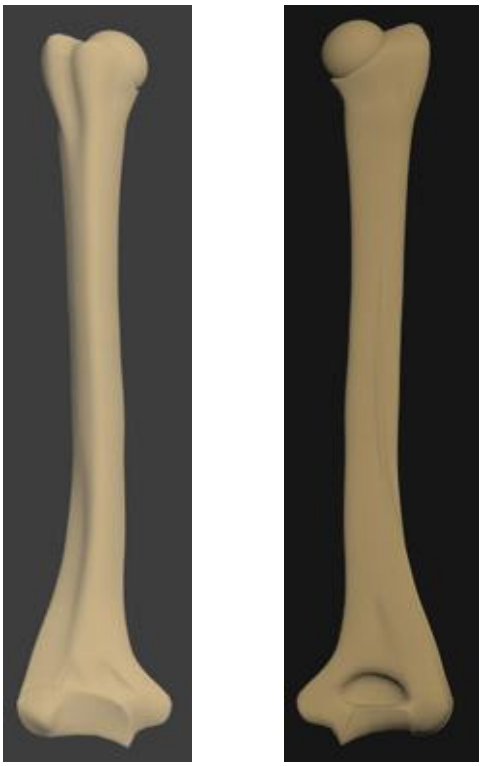
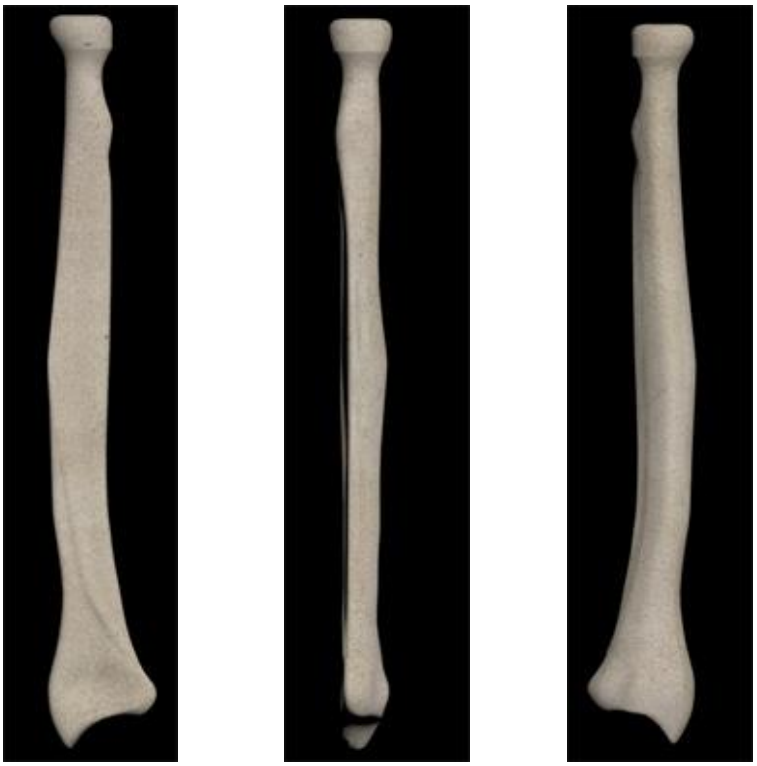
Legend

1. "Unity" is a good choice of engine.

2. The software “Autodesk 3D studio max” is used for elaboration of 3D models.



3. Humerus – 6 646 polygons



4. Radius – 5 148 polygons

5. Ulna – 16 598 polygons