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ENHANCED EDUCATIONAL MOBILE AUGMENTED REALITY APPLICATION FOR MUSCULOSKELETAL SYSTEM AND WARM-UP EXERCISES

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ABSTRACT

The purpose of this study is to examine the use of augmented reality technology in the field of sports science and to develop a sample educational software including musculoskeletal system and warm-up exercises. Each stage of the software development process is explained in detail. The basis of augmented reality technology is the simultaneous visualization of real and virtual objects through an interface system. The instant information obtained by using various methods from the real world is presented in interaction with virtual objects. Virtual objects are developed with three-dimensional modelling software. Code libraries are used for applications that will be created for products such as mobile phones, tablets, and computers. The compiler software makes applications available for use. In this study, Daz3d and Blender software were used for three-dimensional modelling. The Vuforia system has been preferred as an augmented reality code library. The Unity software was used in the development and compilation of the application. It will be beneficial to use the developed mobile augmented reality application in sports and health education. Augmented reality technology can be used in many different areas in sports science.

Contribution/ Originality: This study is one of the few studies in which an educational mobile application has been developed using augmented reality technology in the field of sports and health sciences. Each stage of the software development process has been explained in detail and contributed to the literature.

1. INTRODUCTION

Individuals in all age groups need to do sports to lead a healthy life. Individuals who do not have sufficient time for regular walks during the day are directed to high-impact performance sports. Warm-up exercises should be included before professional or amateur sports. Warm-up exercises increase the body temperature and flexibility of the athletes and also prevent injuries. Athletes should be informed about warm-up exercises. Training should be given to all age groups about muscles affected by warming exercises and the skeletal-muscular system involved in the formation of movements.

It is thought that the use of technology will contribute to learning processes while giving training on the skeletal-muscular system and warm-up exercises. The use of technology in education prioritizes individual learning, allowing the student to learn at their own pace and in a way that they can understand. With the acquisition of information from the primary source and using over and over again provide diversity and opportunity equality. In this way, the quality of education is improved. Although we live in a three-dimensional world, generally preferable to two-dimensional materials in educational processes for reasons such as suitability, flexibility, mobility and economic (Kesim & Ozarslan, 2012). To eliminate these reasons and avoid restrictions on two-dimensional environments, the use of technology must be increased. Technology encourages students to use their imagination and creativity (Klopfer & Yoon, 2005). It eliminates differences in learning speeds and styles. The number of various technologies used in education systems such as augmented and virtual reality is increasing day by day.

Augmented reality technology is applied in medicine, marketing, museums, fashion and many other fields with the ability to combine reality and digital information (Berryman, 2012). The review study in 2003 and 2013 shows that augmented reality technology is a promising technology to improve student learning performance and motivate students to learn through the interaction and graphic content used (Bacca, Baldiris, Fabregat, Graf, & Kinshuk, 2014). As a result of examining 58 articles published between 2006 and 2016, it has been determined that augmented reality applications are used to increase academic success, improve learning performance, increase learning motivation, diversify perceptions, increase satisfaction in learning processes, and enrich learning environments in terms of learner-interface (Altinpulluk, 2019). The review states that the majority of studies 74% use Three-Dimensional (3D) for many tasks in anatomy education and shows that student perceptions are positive towards technology (Hackett & Proctor, 2016). ARBOOK software developed with the support of augmented reality technology for anatomy education seems to increase the success and motivation of students, help autonomous study, and therefore it is suitable for anatomy education (Ferrer-Torregrosa, Torralba, Jimenez, García, & Barcia, 2015). It has been determined that the lessons presented in special stereoscopic and photo-realistic views using augmented reality technology make it easier for students to recognize, memorize and understand the concepts of Biology (Weng, Bee, Yew, & Hsia, 2016). In the study evaluating the ARTutor platform supported by augmented reality technology, students stated that they generally feel comfortable using the software, they are satisfied with the software in terms of efficiency and they will recommend the software to their colleagues (Lytridis & Tsinakos, 2018). As a result of the implementation of the virtual reality technology supported training program for 4 weeks, it has been determined that it positively affects the body composition and health (Lee & Kim, 2018). It was determined that the exercises performed with the developed three-dimensional interactive augmented reality system had a positive effect on balance and mobility in the elderly (Im et al., 2015).

Augmented reality technology is defined as a technology that combines real-world and virtual images and provides simultaneous interaction between real and virtual objects (Azuma, 1997). In virtual reality technology, real or imaginary environments are animated in a digital environment with three-dimensional models. Augmented and virtual reality is two different technologies. Augmented reality experiences take place in the real world where virtual objects are shown interactively. Virtual reality experiences take place in a virtual environment through sensor and visualizer systems.

Augmented reality systems are grouped under two categories according to the technological infrastructure they use: location-based and marker-based (Cheng & Tsai, 2012). Global Positioning System (GPS) data is used in location-based augmented reality applications. Interaction with augmented reality is ensured by using coordinate information of target points. Pointer images are used for interaction in marker-based augmented reality applications.

There are augmented reality applications developed for various technological devices such as mobile phones, tablets or computers. Applications show virtual objects on their screens, such as pre-made three-dimensional models, by identifying markers through the device's cameras. Various software is used in the process of preparing virtual objects. Daz3d is available for creating 3D human models and animations, Blender for 3D models, and a variety of recording and editing software for videos. Objects created in a virtual environment are included in applications through a compiler software using augmented reality code libraries. In this study, applications for the use of augmented reality technology in sports sciences were examined and a sample training software was developed including the musculoskeletal system and warm-up exercises.

2. METHOD

In the process of mobile augmented reality application development, many alternative methods and software are preferred. In this research, the mobile augmented reality application development process consists of the steps of creating virtual objects, uploading marker images into the augmented reality web system then downloading the code library and finally compiling them through the application development software. Each stage of the software development process is explained in detail.

2.1. Mobile Augmented Reality Application Development Process

The human model and animation used in warm-up exercises were created with Daz3d software. Daz3d is a three-dimensional human modeling software that supports Windows and MacOS operating systems. Ready-made human figures and many accessories are available for the users to edit. The created human models have joints such as shoulder, elbow, hip, and knee. Using these joints, it is possible to obtain realistic movements in a three-dimensional plane. It is freeware software (Get Daz Studio & Hexagon, 2019). Figure 1 shows the Daz3d software interface and the developed human model.

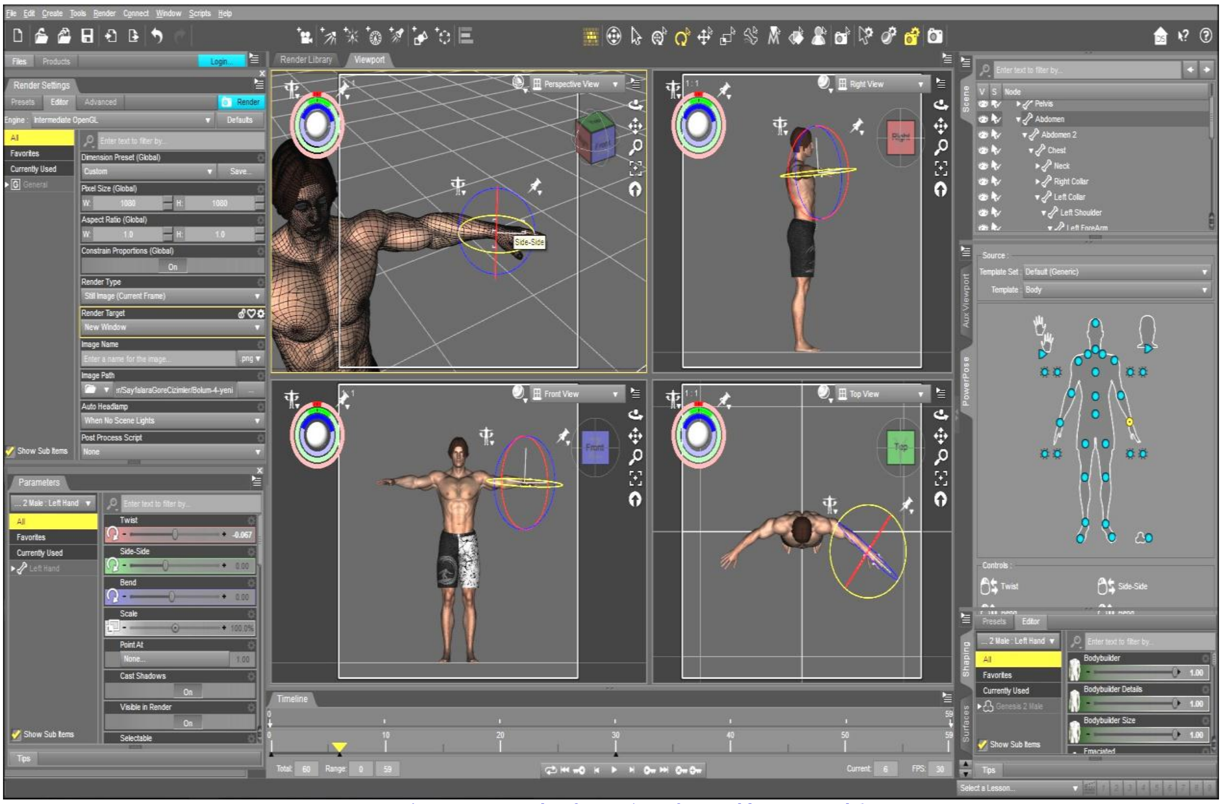

Figure-1. Daz3d software interface and human model.

Three-dimensional images of the musculoskeletal system are created with Blender software. Blender software allows designers to create three-dimensional models. Windows, MacOS and Linux operating systems are supported. It is open-source and freeware software (Foundation, 2019). Figure 2 shows the Blender software interface and an example of the developed three-dimensional musculoskeletal system.

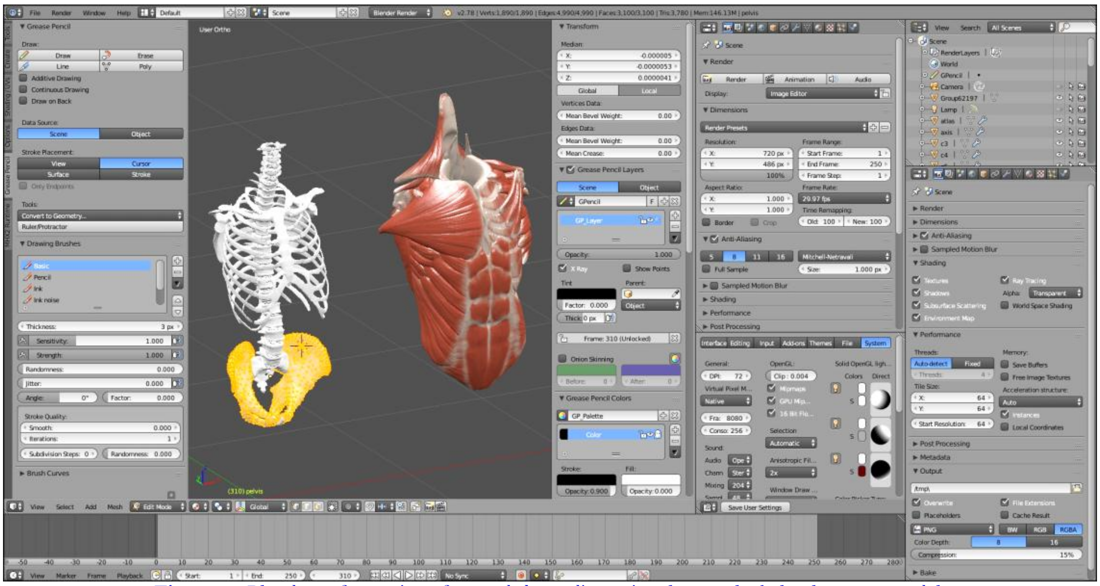

Figure-2. Blender software interface and three-dimensional musculoskeletal system model.

The augmented reality application scans objects in the environment through the camera. When the application detects the pointer object, it shows the virtual content that is available in the system. Markers can be created with image and photo editing software. Designed pointers are recorded in the database of the system, which provides the augmented reality code library.

Vuforia system was used as an augmented reality code library (PTC, 2019). It is possible to create a database by uploading pointers in a freeway, with restricted usage. The prepared database, code library and license key are provided for use in the application development process. Figure 3 shows a sample marker image and identification points in the system.

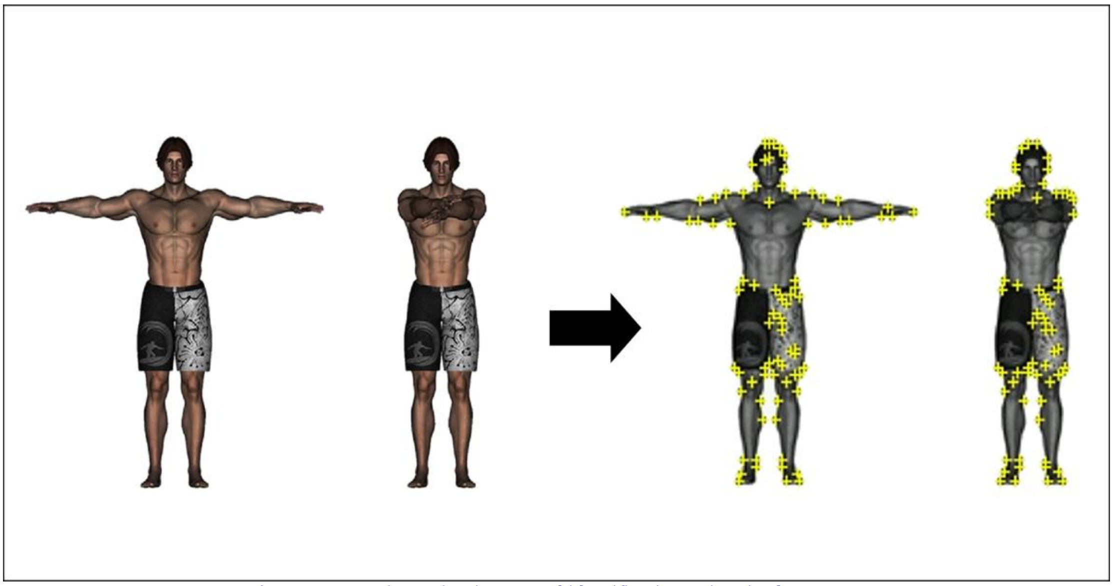

Figure-3. Sample marker image and identification points in the system.

The augmented reality application was developed and compiled with Unity Editor. The Unity editor supports many platforms such as Windows, macOS, Linux and Android (Unity Technologies, 2019). The compilation result is a mobile app file with .apk extension, developed in accordance with Android platforms. Suitable for use via Tablet or phone. Figure 4 shows the Unity software interface in which the application is developed.

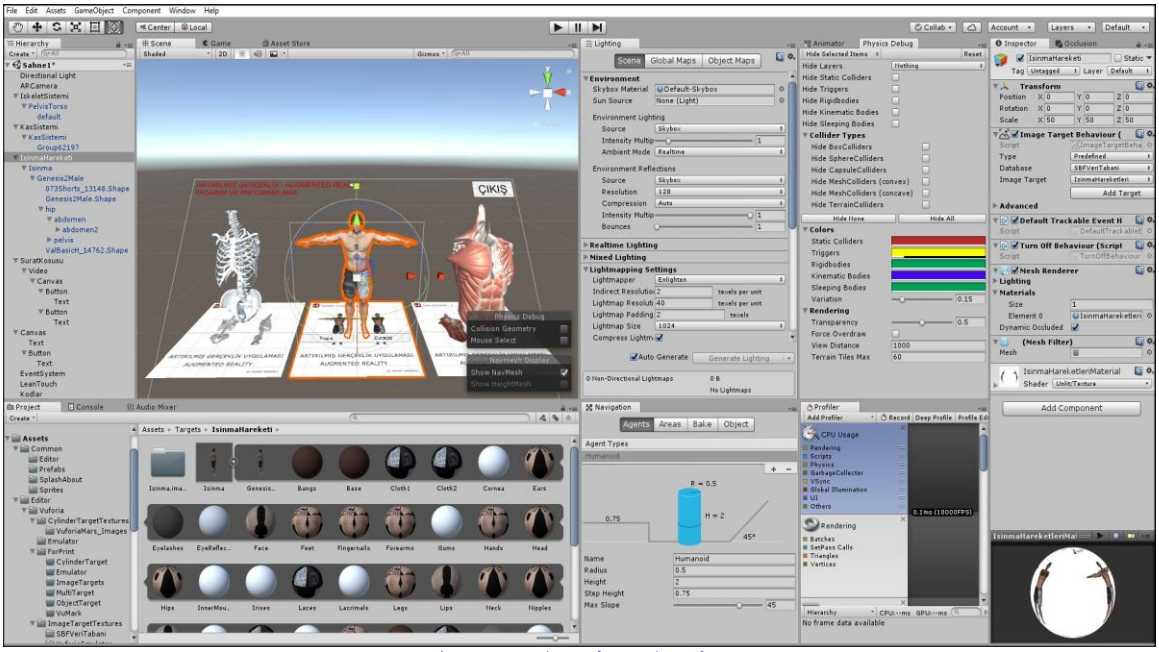

Figure-4. Unity software interface.

3. RESULTS

As a result of the study, the mobile application developed with the support of augmented reality technology contains two different sample models designed in three dimensions. The model, which is related to the musculoskeletal system, allows the examination of muscle and bone structures in 3D. The model, which is related to warm-up exercise, is designed as a 3D animation and allows movement to be examined. Students using the application will have the opportunity to analyze in more detail by enlarging both sample models. Since the designs are 3D, students will be able to examine the models from any angle they want. In the warm-up exercise model, they will be able to follow every stage of the movement.

In the developed mobile application, the focus is on application development processes and approaches. Developers and educators who are familiar with application development processes will be able to develop similar applications in line with their needs. The mobile application has been developed on the android platform and has not been installed in the store, so restricting access to the application is an important limitation. It will be beneficial for researchers to develop applications that will support mobile operating systems other than android and make them available in various application stores. Including students' views in application development processes will increase usability. It would be positive for researchers to develop similar projects with open source and in a way that everyone can contribute.

4. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

It is thought that it is useful to have augmented reality applications in sports science education. An educational augmented reality application provides a detailed analysis opportunity with a three-dimensional representation of movements or objects without a time limit. Augmented reality technology attracts students interest and attention. It helps to learn by providing the appearance of objects from different angles in the three-dimensional environment of subjects that are difficult to understand (Hsiao & Rashvand, 2011; Kerawalla, Luckin, Seljeflot, & Woolard, 2006). According to the demands of education, it will be very critical for physical educators who provide online education to consider the use of technology to improve student learning in virtual environments (Goad, Towner, Jones, & Bulger, 2019). Mobile augmented reality applications support many technological features, so they can be used in a variety of educational processes from material development to orientation activities (Demirer & Erbaş, 2015).

Augmented reality applications help create a three-dimensional form of objects that are difficult to achieve or inaccessible in the real world (Finkelstein, Perkins, Adams, Kohl, & Podolefsky, 2005; Shelton & Hedley, 2002; Yuen, Yaoyuneyong, & Johnson, 2011). The use of skeletal and muscular models developed in a three-dimensional environment provides review opportunities that students cannot achieve in the real environment. Models used in anatomy education do not fully support individual learning. There are disadvantages, such as a limited number of the models and usually not accessible outside of the academic hours. Models offered with augmented reality applications eliminate these limitations. It is possible to examine the structures and working principles of muscles and bones with augmented reality applications using three-dimensional virtual models. Augmented reality applications are considered to be effective, highly interactive learning materials that contribute to the learning process, are easy to use and provide user satisfaction (Taskiran, 2018).

Augmented reality applications positively affect the participation of disabled people in educational games (Bai, Blackwell, & Coulouris, 2013; Zarzuela, Pernas, Martínez, Ortega, & Rodríguez, 2013). Augmented reality applications for many groups of disabilities should be developed as in the case of an application where letters are defined as pointers and translated into sound by the software. In preschool education, it is seen that augmented reality practices have attracted children's interests and motivations in teaching letters, numbers and other fundamental concepts (Rambli, Matcha, & Sulaiman, 2013; Tomi & Rambli, 2013; Yilmaz, 2016). Augmented reality applications for fundamental movement skills, which have an important place in preschool education, should be developed. Children should be ensured by examining each movement and skill in a three-dimensional environment through the application.

The concepts of recreation and tourism are defined as the whole of the activities that people have performed to find peace. Visits of museums have an important place among these activities. Historical events should be assessed according to the time they occur. In this respect, the display of period properties is important in historical examinations for education and tourism purposes. Presenting events and venues in a real atmosphere adds an objective perspective to the assessments. With augmented reality technology, it is possible to accomplish them. The use of augmented reality applications in historical and touristic places is important for the visitors to feel into the historical process and to demonstrate how historical artifacts are (Sertalp, 2017). For this reason, augmented reality applications that host three-dimensional historical models for museums and educational environments should be developed and their usage should be increased.

In this study, the mobile application developed in accordance with the Android platform will be useful to be updated on all platforms. It will enable the application to be publicly available for download from the application stores and various media. It is necessary to increase the number of warm-up exercises and models belonging to the musculoskeletal system in the application. The development of similar applications with virtual reality technology should be encouraged.

The number of academic publications including the development processes of three-dimensional educational content should be increased. Courses that will improve technical knowledge and hardware for content development and use must be organized. Augmented reality training should be given in undergraduate and graduate programs. It is thought that using virtual objects during the competition or training will be beneficial. There are many different implementation areas where virtual objects can be used. It should be ensured that the use of technologies such as virtual offside line representation in football should be expanded. Depending on the type of exercise in training augmented reality applications should be designed and used to show which muscles are working instantaneously. This study will contribute to augmented reality studies in sport sciences education and other areas.

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