CONTRIBUTIONS REGARDING THE DEVELOPMENT OF AN AUGMENTED REALITY APPLICATION FOR THE MEDICAL FIELD

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ABSTRACT: Augmented reality technology has grown significantly, with applications developed for education, gaming, and advertising. However, its potential in the medical field is still underexplored. This research contributes to this area by developing an augmented reality application using Unity that detects and displays a medical prosthesis via QR code scanning. The app enables patients and medical professionals to interactively visualize a virtual prosthesis, improving understanding of its form and function. Moreover, the app supports medical education by facilitating learning for students and professionals about medical prostheses and related procedures. This paper details the development process, from planning and design to implementation and testing. This contribution aims to expand augmented reality in the medical field, with the potential to enhance medical care and education.

KEYWORDS: augmented reality, Unity platform, QR code scanning, virtual prosthesis, medical education.

1. Introduction

In the age of technology, medicine and technology collaborate to improve patient care and access to quality medical services. As the population ages, the number of patients with chronic medical conditions also increases. These patients require long-term medical care and personalized treatments that allow them to live as active and independent a life as possible. In this context, augmented reality can play an important role in improving healthcare and patients' lives.

Augmented reality is a technology that allows the addition of virtual elements to the real world in an interactive and dynamic way. This technology can be used to improve patients' and doctors' understanding of medical procedures, health status, and the healing process. It can also be used to create 3D models of organs or body structures for a better understanding of medical conditions. In addition, augmented reality can help reduce anxiety and pain associated with medical procedures through games and other interactive technologies.

2. Current Status

In an attempt to understand the current status and review some of the existing literature in the field of my work, I have studied several sources of information, of which I will discuss the most relevant ones.

In an article entitled "Simulation in healthcare education: A best evidence practical guide. AMEE Guide No. 82," the directors of the simulation department at the University of Miami Miller School of Medicine discuss their journey of introducing medical simulations in education. Ivette Motola and John Sullivan present the difficulties encountered, from finding a suitable common curriculum to obtaining the support of colleagues and contributing to raising awareness of the importance of simulators. [1]

In a broader study, Dimitrios Chytas et al. extensively discuss the results obtained by several researchers in their attempt to implement augmented reality simulations in the education they provide. Most of the results are positive: often, those who benefit from education use the models successfully, and thus have the opportunity to experience unique experiences, such as observing abnormal anatomical models, simulated dissection of endangered specimens.[2]

Researchers Ho-Gun Ha and Jaesung Hong from the Daegu Institute of Science and Technology in South Korea publish an article entitled "Augmented Reality in Medicine". Within this, they present and analyze 4 augmented reality configurations designed to serve the education of doctors in various fields: cardiac, bones, sinuses, and spine.[3]

In a paper from 2012, two Malaysian researchers named Nur Intan Adhani and Dayang Rohaya Awang Rambli conducted a study on mobile augmented reality and its various applications. "A Survey of Mobile Augmented Reality Applications" presents the involvement of technology in entertainment, medicine, education, marketing and even in protecting the cultural identity of historical sites. Their study encounters an obstacle in observing Western medical applications, as this knowledge was not popularly available to the Asian world at that time.[4]

A highly complex study by Elton Ho, Jack Boffa, and Daniel Palanker is titled "Performance of complex visual tasks using simulated prosthetic vision via augmented-reality glasses". In their experimental work, they use augmented reality glasses to partially restore the vision of people with an ocular condition. The results are significant and represent a solid foundation on which an even more complex system can be developed to complement the work of the three.[5]

One of the most relevant studies for the current work is called "Upbeat: Augmented Reality-Guided Dancing for Prosthetic Rehabilitation of Upper Limb Amputees". Conducted by Marina Melero et al., the study presents an application created through the Unity platform, whose purpose is to assist in the therapy of patients who have suffered upper limb amputations. The components included in the AR configuration, the movements performed during therapy, and the effects on the muscles are analyzed, as well as the results obtained. [6]

Other relevant studies include "Exploring virtual reality and prosthetic training" by Ivan Phelan et al. [7], "On the use of Virtual and Augmented Reality for upper limb prostheses training and simulation" et al., or „Technological Advances in Prosthesis Design and Rehabilitation Following Upper Extremity Limb Loss" [9] written by Taylor J.Bates and his colleagues.

3. Methodology

Unity is a versatile and flexible development platform that can be used to create complex games, as well as virtual and augmented reality applications that can be run on multiple platforms, such as iOS and Android. With an intuitive and easy-to-use interface, Unity is the preferred choice of many developers because it allows the creation of applications with complex features without requiring advanced programming skills. Additionally, Unity's advanced features for displaying virtual objects realistically and easily integrating 3D models allow it to position itself as a leader in the development of augmented reality applications.

In addition to its advanced features and ease of use, Unity also benefits from an active community of developers who provide support and solutions to problems encountered, making application development much more efficient. This community also provides access to useful resources and tutorials for those who want to learn and develop applications in Unity.

For example, an augmented reality application can be created using Unity to scan a QR code and display a prosthesis on the phone screen. The advantage of using Unity in this context is that it provides a smooth interactive experience for the user and allows easy integration of 3D models into the application.

Although the process of creating an application in Unity may vary depending on the project, there are some general steps to follow, including developing a clear idea of what is to be created, creating 3D models or importing existing models into Unity, integrating them into the application scene, and testing the application to achieve the desired final result. It is important to pay attention to all these steps and to perform testing throughout the entire process to ensure that everything is working correctly and in accordance with expectations.

4. Research results

The obtained application is quite simple in terms of functionality, but offers an impressive interactive experience to users. It works through the Android platform and requires direct installation in the device memory. Being compatible with various devices such as mobile phones and tablets, users can access the application on a wide range of devices, as long as it has a built-in camera.

The application interface presents a simplified version of the "Camera" application, offering users the possibility to view the surrounding environment in real-time through the device's camera. However, the application is not limited to this basic functionality. A key element of the application is the scanning of a specific QR code, which activates a recognition software and brings a 3D model of an upper limb prosthesis on the screen. Users can explore this model by rotating the phone and using the device's gyroscope to examine different angles of the virtual prosthesis.

It is important to mention that the 3D model remains visible on the screen only as long as the QR code is in the camera's field of view. When the QR code is no longer detected, the model will disappear. To display the model again, users need to re-scan the QR code. Closing the application and stopping its operation can be done through the phone's application menu.

In developing this simple application, several hours of work were invested, and additional time was allocated to understand the capabilities and basic concepts of the Unity platform. We will now examine some of these in detail. To maintain structured and clear content, we decided to divide the application into three individual activities, which will be analyzed and explained separately. This approach allows us to examine each aspect in-depth and provide a coherent presentation of the application's functionalities.

Task 1: Opening the Unity platform and preparing the project for working with the Vuforia engine

At the beginning of the project, the Unity platform is opened, and a new project with an easily identifiable name is created. For the current project, the 3D Core format was chosen, although there is also a format specific to augmented reality applications, namely AR Core. There are several sources for learning and using the 3D Core format, and AR Core is sometimes unstable, being a relatively new addition to the Unity family. Therefore, we want to work with 3D Core. The project's save location is noted for future reference and easy access. The immediate next step is to prepare the application to work with the Android platform, from the Build Settings menu, under the Files category.

Next, one of the numerous augmented reality engines must be installed in Unity. There is currently a very wide range to choose from, and the subject of the best augmented reality engine can be a research topic in itself. For the current project, the Vuforia engine is chosen for AR application development. Among the main advantages of this engine, we can identify the surface recognition feature, the virtual button usage feature, and the special collision rules. The main disadvantage of this engine is the lack of compatibility with all mobile device models. In addition, there is a long list of advantages and disadvantages that are less relevant to the current project, but which, in perspective, manage to place the Vuforia engine among the best available augmented reality engines for free.

To install the Vuforia engine, the Window category is accessed, and the Package Manager menu is chosen, where the desired package, Vuforia Engine AR, is searched for and selected. The engine is installed. Immediately after installing the engine, it must be validated to function. A activation key is used, which can be obtained for free after registering on the Vuforia developer platform.

In the continuation of the initial setup, the number of images that can be tracked simultaneously by the application must be considered. This feature directly affects the user experience. Depending on the number of images tracked simultaneously, the size of these images, the field of view of the camera, and the performance of the device on which the application is running, the application will run smoother or with interruptions. The standard setting is 1, but the current project uses 8 for the possibility of later adjustment of the application. The device type is selected as "Handheld", meaning mobile, to be held in hand. The "Track Device Pose" options are activated to allow the device to track its position in space, and the "Tracking Mode" is switched to "Positional" to function in accordance with the previously selected setting. After this series of preparatory settings, work continues in the main window of the application.

Thus, to allow the application to work with the device's camera, the "Main Camera" object is deleted from the scene hierarchy, and the "AR Camera" object belonging to the previously installed

Vuforia engine is added instead. Immediately after this, a primary version of the application is obtained, which can be launched with the "Play" button. After launching, the available computer camera starts working, and a camera view appears on the screen.

Task 2: Importing the 3D model and correlating it with a label for Vuforia

In continuation of the project, some key elements need to be brought into the Unity project: the 3D model that we want to display when the QR code is scanned and the QR code label to be scanned.

To import the 3D model, the task is very simple: the 3D model needs to be found in one of the formats such as .obj, .stl, .stp, .jt, or .pvz and brought into the project interface using the "Drag and Drop" technique. Of course, any model can be imported as long as it meets the format and memory restrictions of the application, but considering the purpose of the current application, a model of an upper limb prosthesis is used. The model belongs to me and was created as part of a project that is not relevant to the current work.

For importing QR labels, the situation is somewhat more complicated because these resources must be in a slightly less common format, namely in .unity package. Fortunately, these resources can be found for free on the internet. Once the package with the labels is obtained, it is brought into the Unity project using the same "Drag and Drop" technique, and the program automatically moves this package to the appropriate file for these types of elements.

Once the two elements are introduced into the program, they need to be brought into the application scene to appear in the software. Therefore, an "Image Target" object is created, where one of the just imported labels will appear. Scaled and positioned appropriately in the scene, it is located at the origin of the scene's internal coordinate system for ease of work. Similarly, a "Game Object" object is created to accommodate the 3D model, which in turn needs to be scaled and positioned in relation to the label introduced earlier.

In the image below, it can be seen that both the QR code label and the 3D model of the prosthesis have now appeared in the main Unity window. The 3D model is positioned above the label so that when the code is scanned, the model appears above the code.

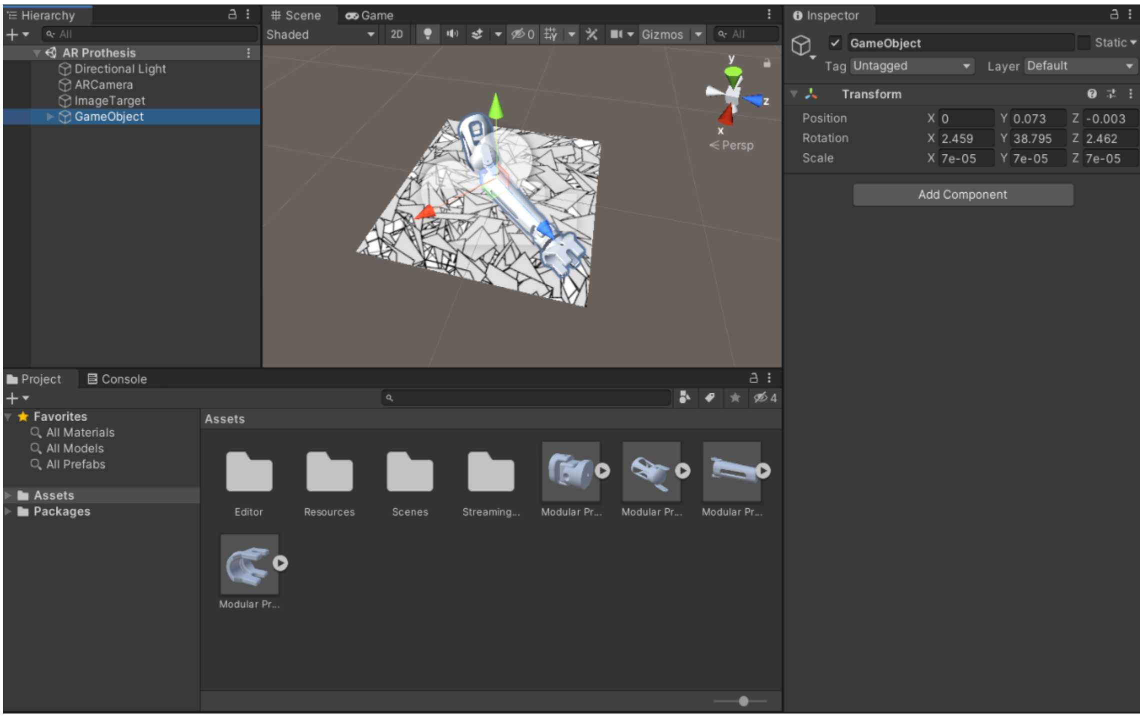

Figure 1: Unity window showing the 3D model of the prosthetic and the QR code label

At the end of this step, the "Game" mode of the application is opened and the appearance of the 3D model when scanning the code is tested. In the image below, it can be seen that when the QR code appears, the 3D model is projected on the screen. In the case of the present test, the QR label can appear in any form, whether it is a code on a mobile device or on paper, in physical format.

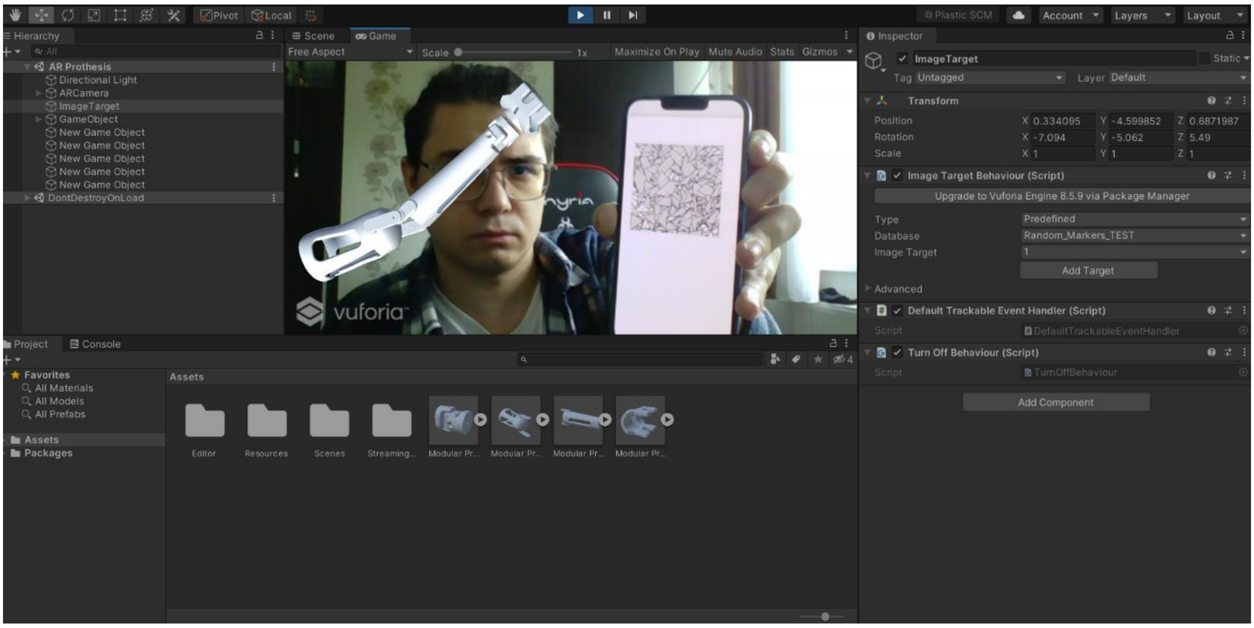

Figure 2: Unity window showing the "Game" mode activated

Task 3: Preparing the Application for the Android Environment

For this task, we first need to remember the preparatory step taken during Task 1, when the entire project was set up for the Android environment. Continuing that step, we now need to make some modifications to a regular mobile device to accommodate the "Developer" mode, an option available in the device's settings menu. The "USB Debugging" setting must be enabled to ensure the functionality of the USB cable connection between the computer and mobile device. Finally, connect the phone to the computer.

Once the mobile device is ready, return to the computer. In Unity, under the "Files" category, select the "Build Settings" menu, from where the current scene is chosen as the scene to be run in the application. From the "Run Device" field, select the device on which the application will run. Select the "Build and Run" option, and the application now appears on the mobile device. Finally, test the application on the mobile phone by scanning the appropriate QR code to see the 3D model projected on the screen.

5. Conclusions

After conducting research and developing the application, a software application was obtained whose domain of applicability is mainly in education. This tool can serve both engineers and future doctors as a reference for an easily analyzable upper limb prosthesis model. The tool uses augmented reality technology to bring an element of novelty, thus creating a more interesting and authentic interaction than what would be possible with a simple 3D model.

Considering future research directions, the application creates many such directions. One of the first ideas that comes to mind is porting the application to more devices, including those with the iOS operating system. As a primary functionality, the application can be improved in many ways. Firstly, by using more different labels and more 3D models, more examples of models can be recognized and displayed. Undergoing many modifications, the application could reach a point where it takes more input data such as a person's height and weight to display a personalized model of the prosthesis, specific to the individual's dimensions. As a secondary functionality, the application can be improved by introducing a user interface. Considering the use of the Vuforia engine, it is possible to integrate buttons that can have different functions, such as closing the application, switching between models, or even rotating or scaling the displayed model.

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