



INTERNATIONAL RESEARCH ACADEMY OF
SCIENCES, ENGINEERING AND ADVANCED TECHNOLOGIES

ANATOMY WORLD: AN AUGMENTED REALITY MOBILE APPLICATION TO TEACH ANATOMY TO SCHOOLS' STUDENTS

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ABSTRACT

Students in secondary schools face troubles in understanding scientific materials, especially biology, in the perception of organs and functions of the human body as it should. The use of augmented reality technology can contribute to the enhancement of the educational process more than traditional means. Anatomy world is an android application with augmented reality technology that enables the students to see the three-dimensional view of the human body and interact with it. In addition, the application allows switching the language from Arabic to English and vice versa. We followed the Scrum framework. Throughout sprints, we conducted a questionnaire to measure the application usability and collect the needs of students and teachers in schools. Anatomy World is then developed using a C# programming language for building the application in the Unity3D and Visual Studio programs. Very satisfying results were collected after conducting Application Usability testing for both Students and teachers. The results of usability testing proves that Anatomy World could be as a step to support and promote education, by expanding students' perceptions, encouraging them to learn, and promoting understanding of biology by students in schools and making education more fun compare to boring and traditional methods.

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Keywords: *Augmented Reality, Mobile Application, Technology in Learning, Scrum, Interactive Education.*

1 | INTRODUCTION

Nowadays, students who learn human biology in schools use textbooks, text media, and images, all of which are considered as traditional methods that have many disadvantages, including they are not based on interaction, since only the interaction is done between the teacher and the learner, but not always between the learner and the book. The book is a traditional means that does not attract attentions. Biology books contain a lot of knowledge and information in the form of texts and images that maybe considered a concern for students about the possibility of studying a large amount of information without the ability to understand and imagine the book's images as it should. We propose that using AR technology in school, where the main advantage of using AR in the education field is that it will change the learning methods and interaction with it by students. AR will increase student's interaction and attendance in the school's classroom by making content easy to understand and display them in the form of 3D images, videos, and graphics, etc. Thus, by using AR technology in school, the students can understand the topics and lessons clearly and this will make education more interesting and interactive. The student can use their smartphone to learn anytime from anywhere they preferred rather than going through several reference books [1].

The problem is the difficulty of students in visualizing the human body, in terms of distinguishing between different internal organs. It also considers a challenge for teachers to describe organs in terms of their shapes and sizes for students to increase their understanding. In addition, similar applications do not support the Arabic language.

The rest of this document is organized as follows: section 2 introduces the problem statement, section 3 describes related work, section 4 presents the proposed solution, section 5 presents the results of testing, section 6 discusses the problems and challenges, section 7 is the conclusion, and finally, section 8 contains some recommendations for future works.

2 | RELATED WORKS

2.1 | INSIGHT HEART

This app is an expedition to the human heart where it shows four different heart diseases (normal heart rate, myocardial infarction, arterial hypertension, arterial fibrillation). It also includes an EKG simulation and gestures (rotate the heart, animate the heart, heart scene), a high-quality 3D model and animation [2].

2.2 | HUMAN ANATOMY ATLAS

Human Anatomy Atlas has many features that help in realizing the way the human body working and visualizes its internal organs [3]. These are:

- Zoom in/out
- Rotate/flip
- Hide/peel away structures and layers
- Fade and isolate
- Highlight all models.

2.3 | MUSCLE PREMIUM

It has features that allow the user to interact with 3D models of the human body such as nerves, bones, vasculature, bursae, and ligaments. This app can be used for special conditions and injuries [4].

3 | PROPOSED SOLUTION

Due to AR characteristics, we decided to develop a mobile application, namely Anatomy World that supports AR and allows students to view a three-dimensional vision of the human body. Students can choose the human system they would like to see the internal details of its organs. The human system will appear with full organs. The organs sequentially will be numbered for easy to understand the track of the operation of that human system. Each organ will be displayed with its term in both Arabic and English languages. In addition, the application allows the user to interact with organs and compare their sizes with each other. Objectives of Anatomy World can be summarized as:

- Provide a three-Dimensional vision of the human body to help to understand and communicate how the human body looks and works. It includes textbook-level definitions.
- Identify the scientific term for organs in both Arabic and English languages.
- Ability to compare the human organs.
- Enable to understand the sequence of operations for a specific organ.

Our application is dedicated to all private schools in Saudi Arabia, where we target students in the secondary level of education in biology subject as well as the teachers that are specializing in explaining biology, to help them to explain lessons and information more efficiently. It also helps the student at any level to visualize the human body with its internal organs in a three-dimensional vision with a brief description of functions around all human systems. The description will be in simple and clear words that each student can understand at any level of education. For this purpose, we chose a private school called *روضة السليمانية الأهلية* to implements and test our mobile application. The reason behind our selection of private school is that they always seek to improve and develop teaching methods, where it can possible to provide technology and the use of innovative teaching aids for students and teachers as well as the financial possibilities available. This gives an additional advantage to private schools, because of their ability to spend more.

3.1 | METHODOLOGY

In this project, we decided to choose the type of agile development "Scrum". An agile process helps to focus on accomplishing the main objectives of the business in the lowest time. The agile examines actual working software rapidly and frequently. It supports accountability, communication between the teamwork, and repeated progress to achieve the target goal [5, 6].

3.2 | REQUIREMENTS

3.2.1 | Functional Requirements

Functional requirements define the basic system behaviour. Essentially, they are what the system does or must not do, and define how the system responds to inputs. If the functional requirements are not met, the system will not work. The students can choose the human system they would like to see the internal details of its organs. The human system will appear with full organs. The organs sequentially will be numbered for easy to understand the track of the operation of that human system. Each organ will be displayed with its term and a brief description in both Arabic and English languages. In addition, the application allows the user to interact with organs and compare their sizes with each other.

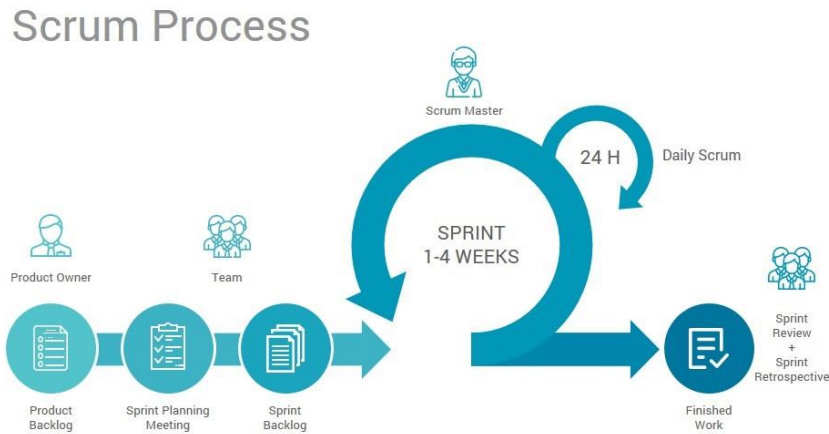


Figure 1: Scrum Process [7].

The tasks or functions that the application is required to perform are:

- Change languages in the app.
- Show instructions and guidelines for the initial users.
- Scan for book’s images to view them in 3D
- Rotate and zoom in 3D
- Show the organs in each system in sequential numbers based on their operations.
- Display anatomy labels.
- Display brief descriptions of each human system.
- Audio for pronouncing each organs' terms in both languages.
- Grabbing property which means the ability to hold and disassemble the organs of the human system in one click
- After grabbing property, reset property that can assemble all organs back to their normal positions in one click.

3.2.2 | Non- Function Requirements

Non-functional requirements define system’s behaviour, features, and general characteristics that affect the user’s experience. [8].

The features that the applications will has:

Usability: Our application will be more efficient to use with less time to accomplish a specific task. For example, navigating between the screens or clicking buttons. Also, it will be more satisfying to use by making the buttons large enough and clear through describing their purpose using clear, understandable language either in Arabic or English language.

Availability: Our application can be accessed and used at any time.

Culture and political: Our application will be support multilingual.

Performance: In our application after clicking on any button, the result will be rendered within no more than 1 second on average and it will not take more than 7 seconds in maximum. This speed is considered reasonable/competitive compared to similar existing apps.

Data integrity: The data in our application will be accurate and consistent over the entire application.

3.3 | ANATOMY WORLD MOBILE APPLICATION

C# programming language is used for building the application in the Unity3D and visual studio software. Some screenshots of the application are provided in Figures 2 to 8.

Figure 2 displays language change property in Anatomy World Home page. Figure 3 displays Help page of Anatomy World.

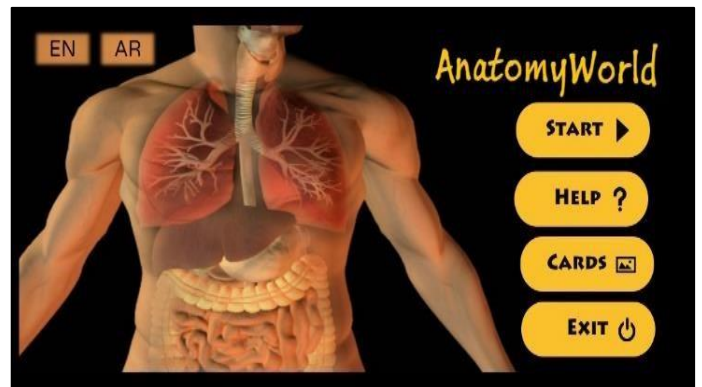
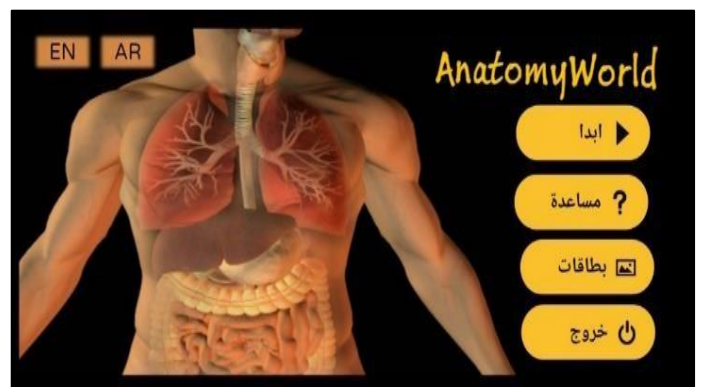


Figure 2: Main menu in both languages.

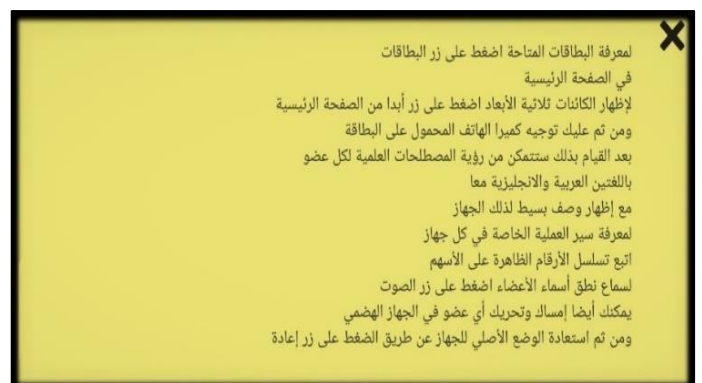


Figure 3: Help page.

Figure 4 displays available cards page of Anatomy World application. Figure 5 displays heart system with its terms and descriptions in Anatomy World application. Figure 6 displays heart system with audio buttons in Anatomy World application.

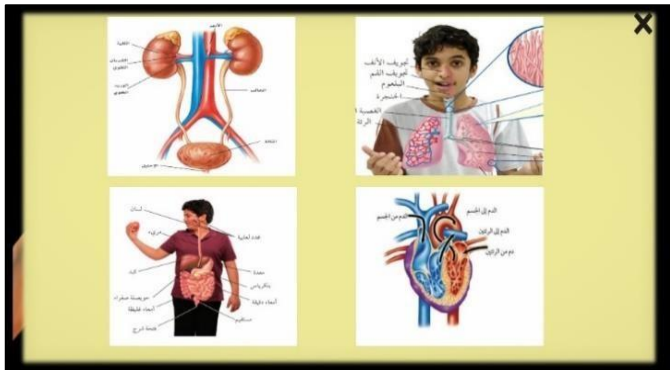


Figure 4: Available cards page.

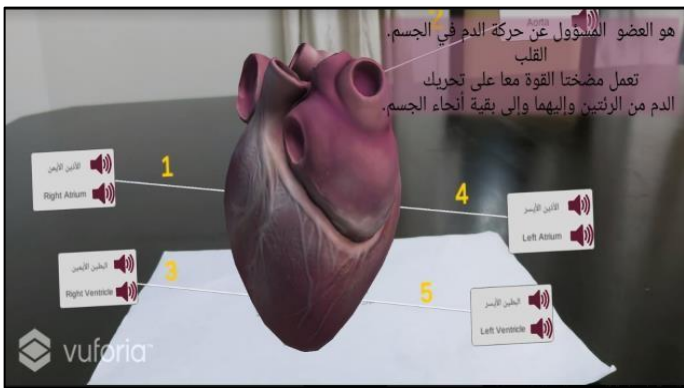
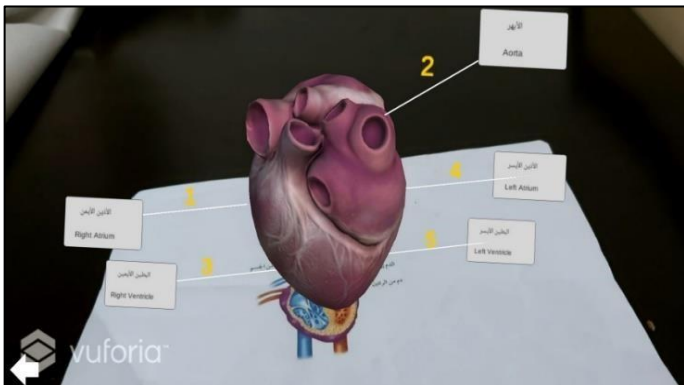


Figure 5: Heart system terms and description.

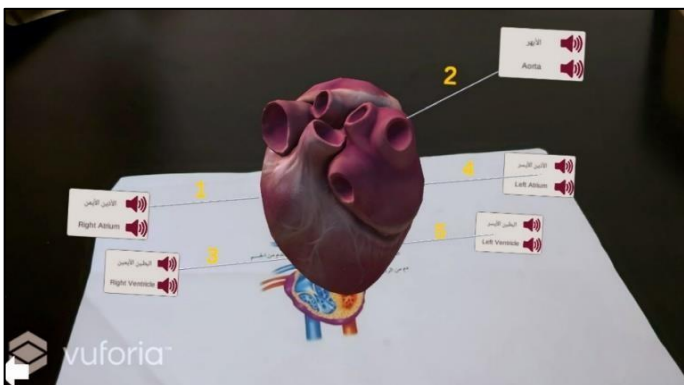


Figure 6: Heart system with audio buttons.

Figure 7 displays digestive system with Grapping and Reset properties in Anatomy World application system. Figure 9: displays 3D rotate property of Heart



Figure 7: Grapping and Reset properties

Figure 8 displays 3D zoom property of Excretory system.

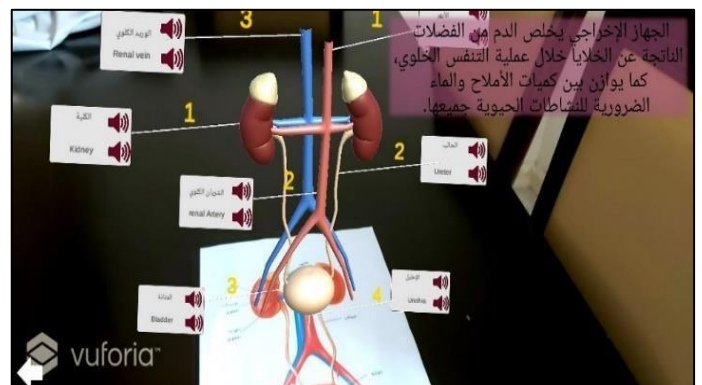
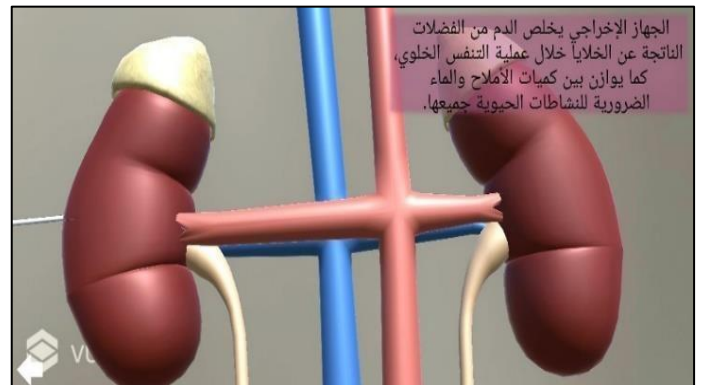


Figure 8: Zoom property

4 | RESULTS

System usability testing results that we have gathered proved an evidence on how much students and teachers were satisfied and the systems was user friendly .The Anatomy World system has been fully tested on a real Android mobile. The expected test results were successfully implemented. Some test examples are:

- Students grab the digestive system. Then return the normal position of all the organs in that system.
- Student makes 3D zoom and rotate of all available human system.
- Student plays the pronunciation of each organ’s terms.

Figure 9 shows that 45% of students sample decided that home interface of Anatomy World app is simple and 35% of them see it very simple. While 20% of them found it hard.

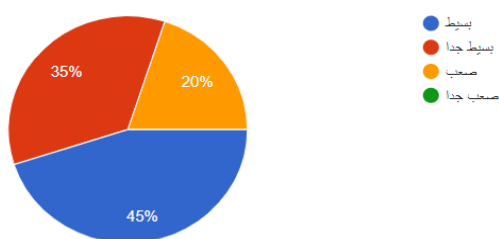


Figure 9: Percentage of students who measure the usability of home interface.

Figure 10 show that 95% of students sample viewed that the icons are very clear and describes its functionality.

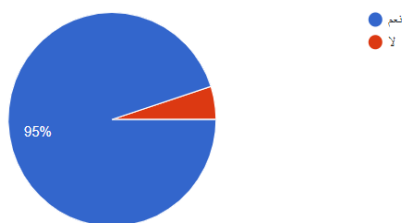


Figure 10: Percentage of students who found the icons are clear.

5 | PROBLEMS AND CHALLENGES

During the work on this project, a problem encountered was the need to use a Vuforia engine that can detect and track the image targets (book’s images). These image targets are assigned a star rating, depending on the quality of the target. The star rating influences the strength of the target concerning detection and tracking. The star rating can vary between 0 and 5 stars. A higher rating is better. Therefore, we changed some of the image targets that have low ratings.

6 | CONCLUSION

The Anatomy World aims enhancement of the educational process in schools and helps to understand scientific content especially biology content in a better way rather than content acquired through traditional means by using Augmented reality technology which

can expand students’ perceptions, encouraging them to learn, makes education more fun rather than boring and traditional means.

To develop this system, we started by defining the problem and the best solution to solve this problem. Then, we chose the Scrum framework as a development process. After that, we conducted an analysis of similar systems to develop additional useful features. Then, we described the functional requirements and non-functional requirements of the Anatomy World application. According to the Scrum methodology, we described the functional requirements through designing a high-fidelity prototype by analysing some of the user stories with sequence diagrams and testing through unit testing usability testing of each Epic.

7 | FUTURE PLANS

The following are future development plans of Anatomy World application that we hope to accomplish:

First, we will provide 3D objects of all human systems. Second, we would like to add the animated functions of organs. For example, the Circulatory system, which in turn pumps blood throughout the body, as well as the Digestive system, which in turn, processes food in the mouth, stomach, intestine, and Respiratory system that enters oxygen molecules and expels carbon dioxide molecules. Third, we are planning to add an explanation of the most common diseases that can affect each organ in the human body, in addition to showing their symptoms of these diseases.

Fourth, we would like to expand our scope to include all educational levels in schools.

Fifth, we will offer the IOS version of the Anatomy functional World application.

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