

Android Learning App using Augmented Reality

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Article Info

Volume 83

Page Number: 5362-5367

Publication Issue:

May - June 2020

Abstract

Augmented Reality is one of the emerging technologies which will be making a serious impact on the industries of the world. Augmented Reality is not a science fiction concept anymore it has become a science-based realism. With Augmented Reality we can view a digital object coexisted with a real object in our real-world environment in real-time. Due to the improvement of the mobile computing power in recent years Augmented Reality can now be accessible on mobile devices as it no longer requires specialized equipment. Although Augmented Reality is still in its early phases, it is already implemented being used in a variety of different fields. One of the major fields is Education. Education is one of the key organizations that is being used by technology and digitalization such as demonstrating complex subjects which can make it easier for the students to understand. As students tend to use technology for learning rather than reading bulky books. Many young people now have smart phones which we can utilize this technology to enhance our learning methods. As our project's aim is to a mobile application that uses the concept of AR as its base to build a learning platform that will help students to achieve an understanding of what they study in a more fun, innovative and immersive way.

Article History

Article Received: 19 November 2019

Revised: 27 January 2020

Accepted: 24 February 2020

Publication: 16 May 2020

Keywords: component; Learning App; Augmented Reality; Android Application

1. Introduction

Augmented Reality overlays computerized information within the real world to create an immersive environment where the users can explore, engage, interact and learn. The word augmented means to add or enhance our physical real world with a virtual digital object which could be a 3D graphic, sound and touch feedback hence the full form called Augmented Reality. called Augmented Reality. The term Augmented Reality was developed by Thomas Caudell and David Mizell in 1992, two Boeing engineers running on a straightforward see through headset that assisted aircraft engineers in complicated wiring schematics. According to their documentation, the objective of Augmented Reality was to empower cost saving and performance improvement in

numerous human included operations in airplane manufacturing. Before that in 1968 there was a first Augmented Reality prototype created by computer graphic pioneer Ivan Sutherland and Bob Sproull created the first head mounted display (HMD), they called it "The Sword of Damocles", the prototype was substantial, it was required to be suspended from the ceiling by mechanical arm, it was rough device that basically displayed primitive computer graphics. Nowadays, we no longer need such a substantial machine suspended from the ceiling as by today there are two main delivery systems for Augmented Reality content: a headset and mobile. A headset such as Microsoft HoloLens the most widely used HMD on the other hand we have smartphones which is the mobile side of Augmented

Reality as the rapid improvement of smartphones has contributed to growth of the Augmented Reality industries. That's because the identical components that make smart phones work, gyroscopes, accelerometers, high-resolution displays, are also required for AR headsets. With the variety of tools that are available today we can build Augmented Reality applications without worrying of the cost of the development and devices. As Augmented Reality becomes a trending topic in technology with the great capability of how computing power has become many potentials and applications have emerged in the industry. Augmented Reality in Education in Education is still new and settled however plenty of applications are starting to implement this technology in order to enhance the education and learning methodologies. The efforts for the academic growth of a student or any individual different modes of learning and teaching must be considered for a deeper integrated and functional grasp of the subjects or concepts. The responsibility of increasing the interests, design or organize the growth of academics in a child from ones primary level of education to their adulthood, is all in the hands of the education system. In the past 100 years, students were taught through means of lectures on blackboards, hard to understand books and the process of note-taking. The transformation of education is being moved to a new route of innovation known as a smart class. This is designed as a solution to help teachers in challenges related in the development ,performance and understanding of growing children through the means of converting the daily lessons or teaching material to simple animated modules, videos and innovative cognitive games. But this is not enough since we are standing on the brink of the fourth industrial revolution which will alter individual lives in many different ways. Including how we work, how we live and even how we learn. And to cope up with such changes we need a more immersive and fun method of learning which can be achieved by the use of revolutionary technologies such as Augmented Reality.

2. Literature Survey

Augmented Reality blends the real world and the virtual world and enhances the real world with computer generated virtual objects in real time [1]. Augmented Reality enables virtual objects to be added into real worlds to assist real-time interaction [8]. As indicated by one of the most normally acknowledged definitions. Augmented Reality is a technology that has three key requirements: combining real objects and virtual objects in a real environment, aligning them with each other and real time interaction [2,8,9]. In mobile augmented reality, the technology involves the addition of virtual objects to the real world using the camera of the mobile device hence Augmented Reality no longer requires specialized gear and can effectively be utilized through computers or mobile devices [3]. Numerous individuals presently possess mobile phones thus they can use Augmented

Reality [1]. The use of Augmented Reality for learning has been practical because of the improvement of mobile technology as mobile phones nowadays possess fast processors, powerful graphical capabilities and various sensors [4,9]. Augmented Reality mobile applications are available for a number of areas of education [8]. Augmented Reality provides new ways of interacting with the real world which can be useful within the education system [5]. The skills and information that students develop via technology, it may develop effectively through Augmented Reality [3]. The immersion and interaction features offered by Augmented Reality may energize students to participate in learning activities and will improve student motivation for learning [4,9]. Interaction with the real world is very significant in the learning process and through Augmented Reality we can achieve that kind of interaction [4]. Studies suggest that immersion in a digital environment can enhance education in a minimum of three ways: allowing more than one view, situated learning, and transfer. First, the power to vary one's perspective is a powerful means of understanding a complicated subject [10]. Users of Augmented Reality would possibly experience usability issues and technical problems and few students can feel that this technology is convoluted [5]. There are plenty of tools and SDK to build an Augmented Reality application for example ARKit for iOS devices, ARCore for Android devices and Vuforia for multiple platforms [6]. The potential revenue for education in Augmented Reality in 2025 could be estimated at about \$7 million [7].

3. Education in Augmented Reality

In the last few years, the whole world has seen a comprehensive development in all aspects. Modern technologies have become the main driver for various sectors including education with spread of access to the internet and mobile devices make these technologies being widespread and accessible to the public. Education has adopted different types of technologies which change the approaches and the methods of teaching, learning and its strategies of teaching. The traditional approach of learning and teaching such as using hard books is limited to indoctrinating knowledge in a theoretical way that not may not be understandable hence the modern approaches using technology has allowed education to be in form that simulates reality. Universities, schools, educational institutions and training centers strive to provide the latest learning environment such as using Augmented Reality in education despite the limited capabilities. Using technology in education would help the students to achieve the expected goals that would achieve sustainable development. The process of developing applications and educational platforms has become a reality that is accessible and available at acceptable costs, all of which would contribute to facilitating the process of teaching, learning and training. With every new day, we witnessed a remarkable development in the use of information

technology in the field of education. Researchers seek to provide the best technologies and benefit from the latest technology in motivating learners and teachers to make the process of teaching and learning more attractive, enjoyable, interesting and exciting by finally making it an environment which simulates the real world. Virtual and Augmented Reality technologies emerged which easily made their way into the field of teaching and learning, contributing in turn to redefining the concept of education by adding interactive, meaningful technical content that touches the reality around us in a fun and interesting way. Every teacher and trainer wants to use the latest technologies and methodologies to attract student's attention and enhance the effectiveness of his approach to teaching. Augmented Reality technology can encourage students by fetching 2D objects to life such as an object from a textbook can pop up and students can see the object in 3D in a real-life environment and explore and manipulate the virtual object. With Augmented Reality case studies can be solved interactivity for example chemical reactions, students can observe how elements can react with each other by selecting chemical elements, composing into 3D atomic models and rotating them. The interactivity given by augmented reality aids students to learn by doing, an experiential approach is more conducive to acquiring the information than the utilize of eyes, ears and memory. Researchers have indicated that using Augmented Reality in some topics is more effective at teaching than using other media such as books, videos. With the rise of using smartphones among young people as they use smartphones for everything. Many educational institutions try to ban the usage of smartphones however such bans are pointless as young people these days are connected to smartphones the effective approach is to let students use for learning instead of banning. The educational potential of using smartphones with the proper applications is no longer debatable since it can be used in both formal and informal educational settings has become a fact. Using Augmented Reality as a new medium for teaching can offer a unique experience which Augmented Reality offers new ways of interacting with the real world and bending physical and virtual worlds. Augmented Reality can make experience that would not be feasible in either a real environment or virtual environment. Students can experience scientific phenomena. Manipulating virtual objects and observation phenomena that are difficult to understand in the real world can be done using Augmented Reality. This type of learning can motivate and encourage students to have a better thinking skill and increase abstract understanding of phenomena that are difficult to understand. Augmented Reality could help students in visualizing abstract concepts.

Here is the summary of the advantages of using Augmented Reality in education:

- It is cost effective because it has the potential of replacing paper books, posters, printed manuals and etc.
- It provides omnipresent, interactive and situated learning.

- It integrates of virtual environment with real environment.
 - It allows learning content in 3D manner.
 - It can visualize the invisible.
 - It provides a rich interaction.
 - It provides a natural experience.
 - It can be access anytime and anywhere.
 - It makes learning fun and challenges the learner's abilities.
 - It does not require any expensive equipment like Virtual Reality headset.
 - It is available to all because it requires only a smartphone.
 - It connects different fields together such as education and entertainment.
 - It provides scientific material in way that suits younger people.
- However, there are some challenges with using Augmented Reality in Education such as:
- The teacher may lose their control over the students.
 - Students may feel overwhelmed by the overloaded by the amount of the information.
 - Using Augmented Reality may cause usability issues, interface design errors and technical problems.
 - Some students may find this technology complicated.
 - The required knowledge for design 3D objects and programming skills.

In order to achieve impressive solutions and develop Augmented Reality applications, we need to design and coordinate between educators, programmers and designers. Hardware and software technologies plays an important role to develop such application in Augmented Reality which engineers and designers can develop Augmented Reality application however for learning and educational purposes, there is a big need for teachers and trainers who can design learning activities for Augmented Reality. One of the popular applications for Augmented Reality in education is an augmented paper book which includes a digital content in the form of displaying objects which pop up from the maker that is located in the book as same as our module that we built "Augmented Image". These augmented objects create new visualization that help students to grasp the abstract and intangible concepts and phenomena and students can even manipulate the objects by rotating and tilting to experience the virtual contents from different positions. Current smartphones contain a fast processor with a fast-graphic processor, large touchscreens and sensors such as camera, GPS, compass, accelerometers making them suitable for Augmented Reality experience in both indoor and outdoor.

4. Methodology

Rapid Application Development (RAD) is selected as the methodology for the development of the android application. RAD can be constituted as a form of agile software development methodology that utilizes iterative

development rather than sticking to a strict planning such as the Waterfall model. Five main phases have been used for building the application and those are Analysis, Design, Coding/Implementation, Testing and Maintenance.

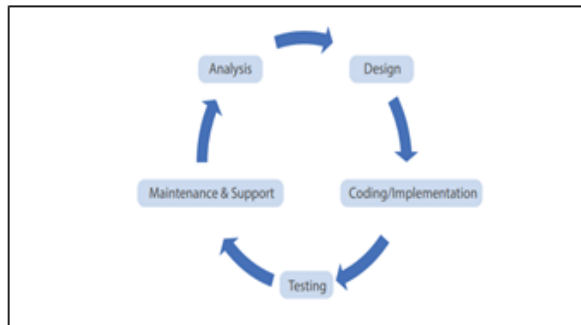


Figure 1: Phases of RAD Development Life Cycle.

A. Analysis

This phase includes different software activities such as software requirement gathering and software planning. We chose from various topics as we divided the application into two different modules as one module is for augmented images that recognize an image and then display a 3D object of that object, the other module is for displaying our solar system in a real life environment.

B. Design

In this phase involves the preparation of the system or software design. Software design will be based on the deliverables of the previous phase, i.e. Analysis phase. The main component of designing the application is the Software Development Kit (SDK) for developing Augmented Reality application. ARCore, developed by Google, is a platform for building modules or experiences in Augmented Reality. Different API's are used which enables mobile phone or other devices with ARCore, to sense the real-time environment, understand it and interact with information. ARCore has three main core capabilities and those are:

1) *Motion Tracking*: allows the mobile phone and other AR supported devices to understand and recognize positions relative to the world..

2) *Environmental Understanding* allows the mobile phones and other AR supported devices to detect the size and location of all types of surfaces: vertical, horizontal and surfaces with various angles like the ground, table or walls.

3) *Light Estimation*: allows the mobile phone and other AR supported devices to estimate the current light conditions in the environment the device is in.

ARCore provides SDKs for many popular software development environments e.g. Android Studio, Unity. We chose Unity editor which is a game engine that is exceptionally easy to use for building 2D and 3D game and graphic application.

C. Coding/Implementation

In this phase, the code is written, which means translating software design into coding and giving life to the design. Since we used Unity for develop the application, Unity has Integrated Development Environment (IDE) called MonoDevelop that allows the user to code in the most popular programming languages such as C#, JavaScript. In our case we used C# because ARCore library built on it. ARCore SDK contains libraries that facilitate and speed up the process of developing an Augmented Reality application.

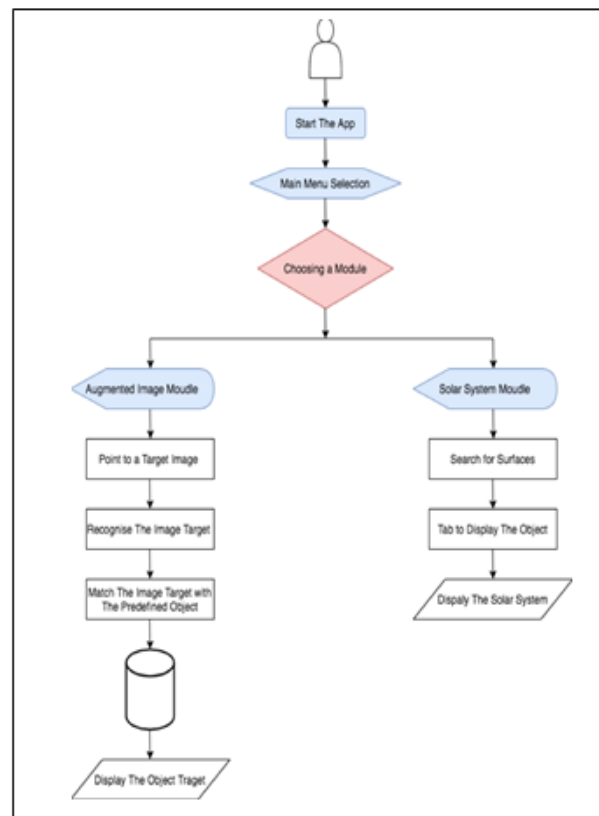


Figure 2: Use Case of the application.

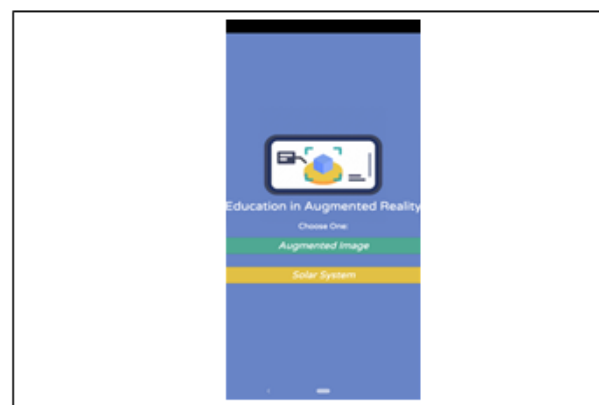


Figure 3: Main Menu Interface.

As the above figure indicates, the application starts with a main menu interface to allow the user to choose the module the user wants to use. For Augmented Image module, the application can respond to 2D images in the user's environment and then place 3D model over them. By providing reference images and ARCore SDK tracking determines where those images are physically located in the environment. Augmented images can be used in printed textbooks that contains referenced images. The working of this module is simple, first you need to point the camera of the mobile phone to a target image, in our example we printed out a picture of an earth, then the application recognizes the image target and matching it with the predefined object in the database of the application, finally it displays the object of the image in 3D. As figure 4 shows.

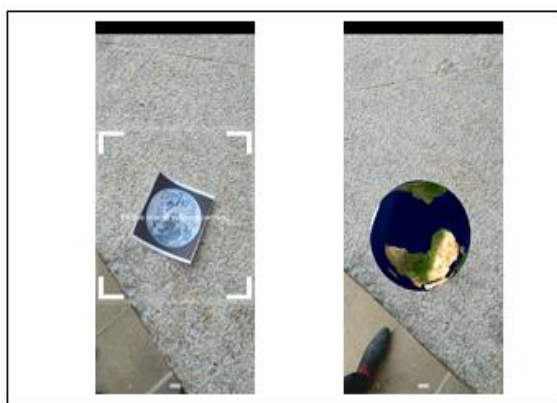


Figure 4: Augmented Image module.

The second module is about displaying our solar system in a real-life environment. One of the features ARCore has is environmental understanding which ARCore looks for feature points in clusters in a way that identifies physical objects or surfaces in the user's reality and this technique is called meshing. The working of this module is the applications first needs to search for surfaces to spawn the solar system on it, when the application finds a surface, it creates a mesh and feature points, then the user can tab on any point from the mesh to display the solar system in the real environment.

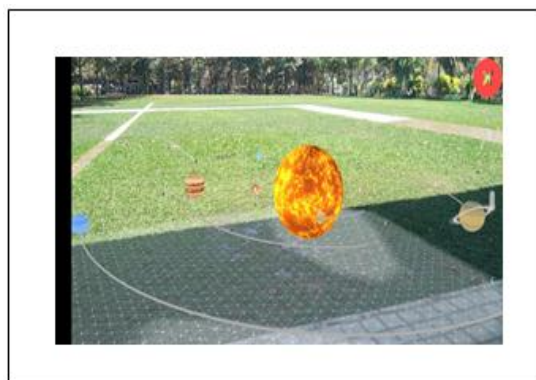


Figure 5: Solar System Module.

The user can tab on the sun or any planet, a panel shown with expanded details of the particular object with the feature of listening to the information by voice.

D. Testing

In this phase, activates carries out to detect or identify bugs/error. Testing are carried out during all the phases of the life cycle.

E. Maintenance

In this phase, the user starts to use the application, finds some problems or errors in it and gives feedback for improving the application and suggesting new features, by fixing those problems and accepting user's feedback is reoffered as maintenance.

5. Conclusion

Utilizing augmented reality in the classroom can transform a conventional class into a connecting with understanding. Augmented Reality innovation gives virtual models. Our application can possibly supplant paper course books, physical models, banners, printed manuals, and so forth. Augmented Reality innovations are promptly accessible for use for most of the intended interest group since most everybody has a smartphone. The intuitiveness managed by our AR application assists individuals with learning by doing, an experiential methodology that is more helpful for information maintenance than the utilization of eyes, ears, and memory alone.

6. Scope and Future Enhancement

When Augmented Reality technology is used in classrooms, students can view models on their own smartphones and get a better understanding of the topics they are learning. It improves commitment, and strengthens understanding. Modern students were raised in a digital age, and they will always be excited about emerging technology that will allow them to learn new ideas and improve their critical thinking skills. Teachers can create an appealing learning environment for students with different learning styles by using Augmented Reality technology in the classroom. With Augmented Reality technology, the knowledge and skills that students build through exciting learning experiences can be developed more easily. By combining multiple sources of knowledge the cognitive workload can be reduced. Augmented Reality's inclusion and interaction features enable students to participate in learning activities, and can improve student motivation for learning.

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