

# Applying Augmented Reality Technology for an E-Learning System

Fetoon K. Algarawi, Wejdan A. Alslamah, Ahlam A. Alhabib, Afnan S. Alfahaid, Dina M. Ibrahim

**Abstract**—Over the past 20 years, technology was rapidly developed and no one expected what will come next. Advancements in technology open new opportunities for immersive learning environments. There is a need to transmit education to a level that makes it more effective for the student. Augmented reality is one of the most popular technologies these days. This paper is an experience of applying Augmented Reality (AR) technology using a marker-based approach in E-learning system to transmitting virtual objects into the real-world scenes. We present a marker-based approach for transmitting virtual objects into real-world scenes to explain information in a better way after we developed a mobile phone application. The mobile phone application was then tested on students to determine the extent to which it encouraged them to learn and understand the subjects. In this paper, we talk about how the beginnings of AR, the fields using AR, how AR is effective in education, the spread of AR these days and the architecture of our work. Therefore, the aim of this paper is to prove how creating an interactive e-learning system using AR technology will encourage students to learn more.

**Keywords**—Augmented reality, e-learning, marker-based, monitor-based.

## I. INTRODUCTION

AR brought education to the next level, especially e-learning. Combining technology with learning creates new era for interactive learning, using AR by integrating 3D virtual objects into real-world environments. With AR, there would be no need to define the learning contexts and environments, as the real-world circumstances we are grounded in define them. With technology, individuals can be the teacher and learner for themselves.

## II. OVERVIEW

### A. Problem Specification and Motivation

Education has not changed for years in terms of teaching approaches and techniques applied. Although we are seeing

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some innovative variability in this area, today millennials feel pretty comfortable with online education, doing research on the Internet, resorting to instructional videos on YouTube and distance learning powered by video technology. Obviously, VR and AR is next. This project is designed to help to transform the traditional concept of incentives in the learning process and to take education to the next level.

Because of inability to explain some subjects and implement it in the real-world, as it may be dangerous or expensive to do, for example, we determined a project to make education easier through imagination.

### B. Study Scope

The aim of the paper is to create an interactive e-learning system using AR technology, by designing the next generation of learning environments. AR can be used in many applications such as:

- Displaying information about a tourist attraction by pointing a phone at it
- Museums
- Medical practice
- Physics
- Chemistry
- Conversation in different languages
- Military
- Weather reporters in maps
- Newspapers and magazines
- History
- Astronomy

The current study will apply AR in the most important field in the world, which is education.

### C. Background

Obtaining information about surrounding objects in an effective way is crucial for people. It is a common case when people want to retrieve information about objects from the real world environment and to be able to interact with such objects as easily as they can [1]. We have confidence in that one of the most powerful uses of virtual worlds will not be to replace the real world, but rather to augment the user's view of the real world with additional information. This idea, introduced by Ivan Sutherland's pioneering work on head-mounted displays, is often referred to as AR [2].

AR technology recently become a common subject to research, and can be defined as a technology that "augments" the existing reality with virtual content. In computer science, AR technology has recently become a common subject for research, and AR can be defined as the technology that "augments" the existing reality with virtual content. AR

represents in computer science, a special field that combines digital data generated by a device with the real world environment. By using AR technology, learning will more interactive and it will enhance the understanding of the real world to users [2].

**D. Definition**

AR can be defined as: Seeing the real world with additional objects generated by the computer, this known as AR Technology [3]. Paul Milgram and Fumio Kishino show the spans of the real environment to the virtual environment and the differences between AR and Augmented Virtuality (AV), where AR is closer to the real environment and AV is closer to a pure virtuality, as shown in Fig. 1 [4].



Fig. 1 Milgram's Reality-Virtuality continuum

**E. History**

The appearance of AR dates back to the 1950s when Morton Heilig, the cinematographer, thought of "cinema is an activity that would have the ability to draw the viewer into the on-screen activity by taking in all the senses in an effective manner" [4]. In 1962, Heilig started to build a prototype that he described in 1955 as "The Cinema of the Future" and termed Sensorama, as in Fig. 2, which he developed before digital computing [4].

Next, in 1966, the head mounted display was invented by Ivan Sutherland as one of the ways to display the AR, as shown in Fig. 3 [4].



Fig. 2 The Sensorama

**F. Future of AR**

Nowadays, the popular application Snapchat allows the user to have an AR scene on their faces by using already existing filters available in the application. It is called Lenses; just point the screen at your face and hold to activate the different

lenses, as shown in Fig. 4 [5].

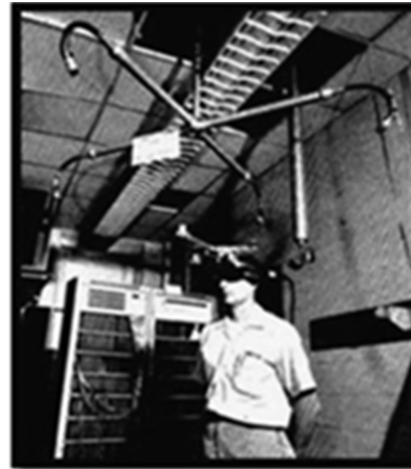


Fig. 3 Ivan Sutherland's HMD [2]

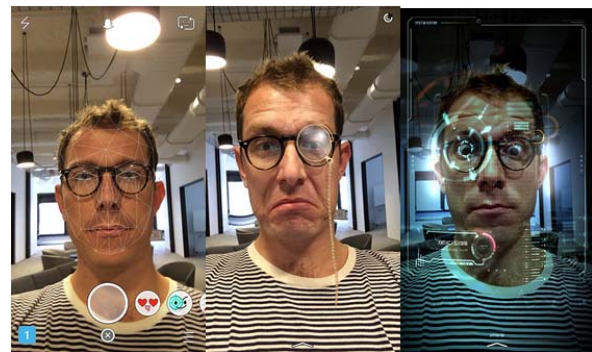


Fig. 4 The lenses of the Snapchat [5]

With the new advances in technology, an increasing number of AR systems and applications are being produced. In the future, the popular author on the subject Tomi Ahonen thinks the number of users of AR by 2023 will be as much as the number of mobile phone users as of 2011.

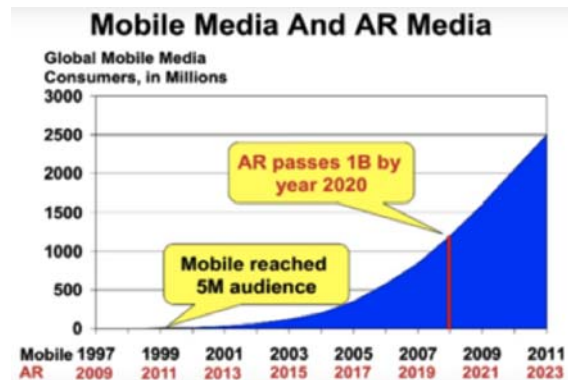


Fig. 5 The 8<sup>th</sup> Mass Medium by Tomi Ahonen at TEDxMongKok

**III. STAGES OF THE PROPOSED SYSTEM**

To succeed in using AR in education, first we need to select the right approach to transmitting virtual objects into the real world scene. The marker-based approach is one of two

approaches using AR.

#### A. Marker-Based Registration Approach

It uses a camera to read a special marker that contains information about an object. The marker could be 2D images, a template marker or different kind of code (Quick Response (QR) code, Barcode).

QR codes are probably the most common form of marker-based AR. Before, it is required to write complicated code to create a QR code, but now we use special smartphone applications to generate and read it. A QR code may contain different content such as a picture, personal information or URL. Advertising and other fields have started to use the QR code as a quick and easy way to access to a website [6].

#### B. Display

There are two methods for displaying AR, which are monitor-based and head-mounted see-through. In this paper, we use monitor-based.

Monitor-Based AR: where all the scenes are outputted by a projector or monitor, is the simplest means of display and has the lowest hardware requirements, as shown in Fig. 6 [7].

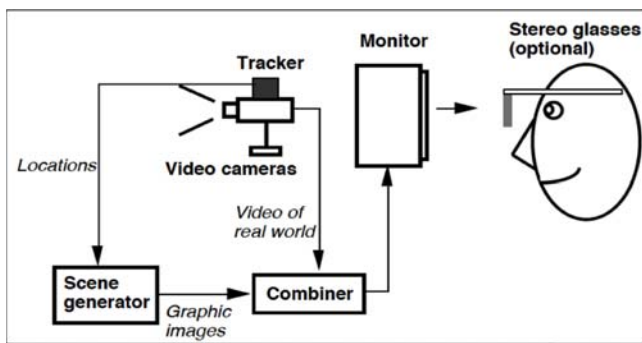


Fig. 6 Monitor-based AR conceptual diagram

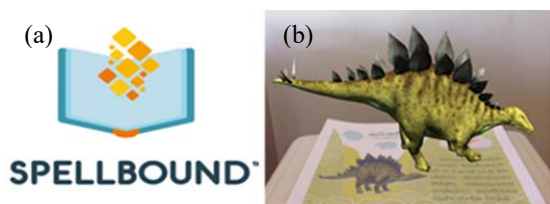


Fig. 7 (a) Application icon, (b) The AR scene shown by the application

#### IV. RELATED WORK

The work presented relates to and incorporates elements from different research areas: AR user interfaces and virtual training. Applying AR Technology for e-Learning systems is closely related to Spellbound (previously known as MagicBook), which is a powerful AR interface. This system uses a real book to transfer users from reality to virtuality. Virtual objects are superimposed on the pages of the book and users can interact with the augmented scene.

The Spellbound application was designed for children. It is focused on the entertainment topics more than the educational

topics. AR is an interesting technology, as it can produce a lot of services, especially in the educational field which makes the understanding of any educational topic become easy, simple, and enjoyable.

#### V. THE PROPOSED ARCHITECTURE

With regard to the application, we will explain how the processes of detecting, recognizing and retrieving objects will be done; the process can be divided into several of processes, as shown in Fig. 8:

- 1) Image capturing: Using the phone's camera to capture the marker.
- 2) Captured image scaling and processing: The application will search for the border of the image to enable moving to the next stages correctly (detection and recognition stages). In this stage, the application generates a copy of the image with a grayscale monochrome to prepare the image for the next stage (detection stage).
- 3) Marker detection: During this process, the application uses the copy of an image with grayscale monochrome from the previous stage to select the border of the image and choose what is inside the border to be the marker that needs to be read to display the content. The application uses special algorithm for detecting objects in an image.
- 4) Marker recognition: The application starts by using a special mathematical equation to calculate the coordinates of 16 points in the original image to determine the color of all 16 points in the original image. Color recognition is based on a comparison of red, green and blue colors of each pixel's color.
- 5) Retrieving object information from the database: All the objects are stored in a local database; each object has unique content related to it. After successfully running all the previous processes correctly, the application will connect to the database looking for a match between the marker and the information about the object. Once a match is found, the application will retrieve the content that is connected to the marker.
- 6) Displaying information to the user: The content retrieved from the previous process (retrieving the object information from the database process) and will be displayed to the user via the screen on their mobile device.

#### VI. REQUIREMENTS

Analysis involves studying the current available systems to lead us to a new system without making the same mistakes. Depending on the analysis of the current systems and the user requirements, we can design an efficient system, and as such, analysis and design are complementary processes to each other.

Through this project, or any project, it is important to collect the system requirements. When you understand completely how your project will appear, you will know what exactly is needed. Once you have created your statement of requirements, ensure the user and all others understand that

this and only this will be delivered [8].

In general, requirements are divided into the user requirement and system requirement.

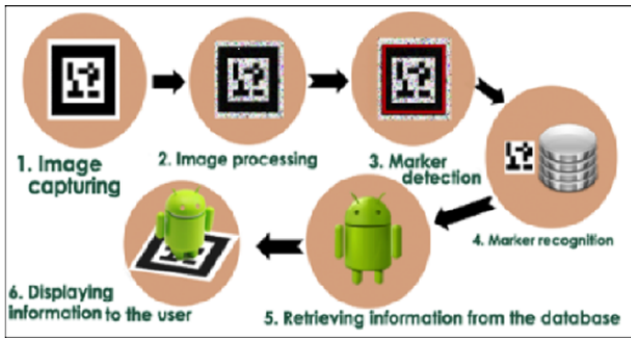


Fig. 8 Our Proposed Architecture Tasks

#### A. User Requirement

The user requirements of the proposed system include the following:

- Readable interface.
- Easy to use.
- The functions that the system was created for are able to work correctly without any errors occurring.

#### B. System Requirement

The requirements of the proposed system are:

- More robust software.
- Reliability.
- High degree of usability.
- Recognize and track dozens of objects simultaneously.

To be used efficiently, all computer software needs certain hardware or other software resources to be present on a computer. The hardware and software requirements of the proposed system are presented below:

#### C. Hardware Requirement

- Tracking (e.g. Marker).
- Input Devices (e.g. Camera).
- Processor (e.g. CPU).

#### D. Software Requirement

- Unity 3D
- Vuforia
- Programming Software (e.g. Visual Studio, Android Studio)
- Operating System

### VII. TESTING AND EVALUATION OF THE PROPOSED IDEA

Our application is based on the Android System. It provides scanning of the marker to display the video or the 3D object; this content (video and 3D object) is useful to understand the subject that the marker is created for it. We collected these markers in a book that we designed; the book is titled, AR to Learn, and is shown in Fig. 9.

There is no need for a user to register to enhance any of the functions, as the application is accessible by anyone. When a user runs the application, the main interface will appear, as

shown in Fig. 10. The main interface includes a list of options you can select to either scan or explore.

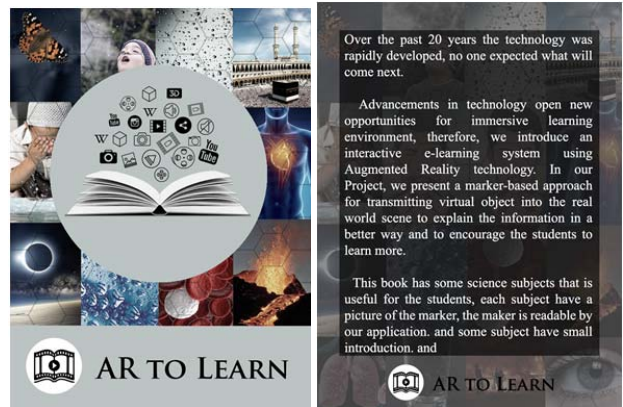


Fig. 9 AR to learn Book

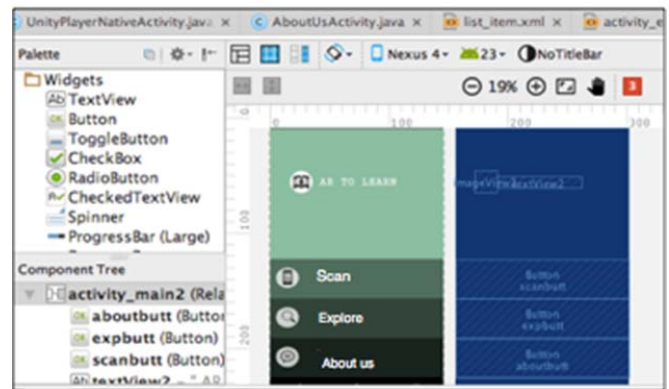
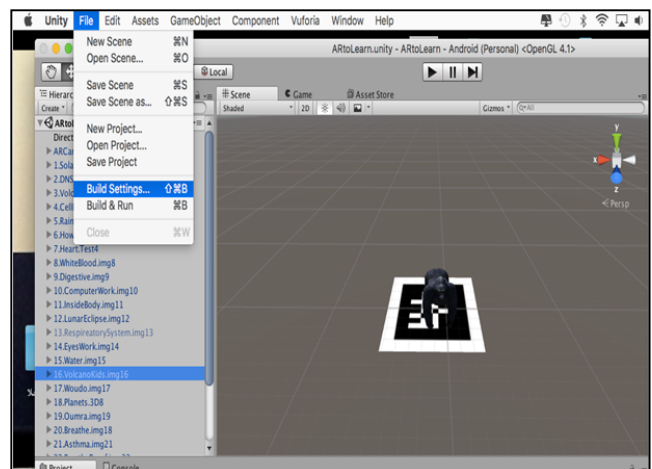
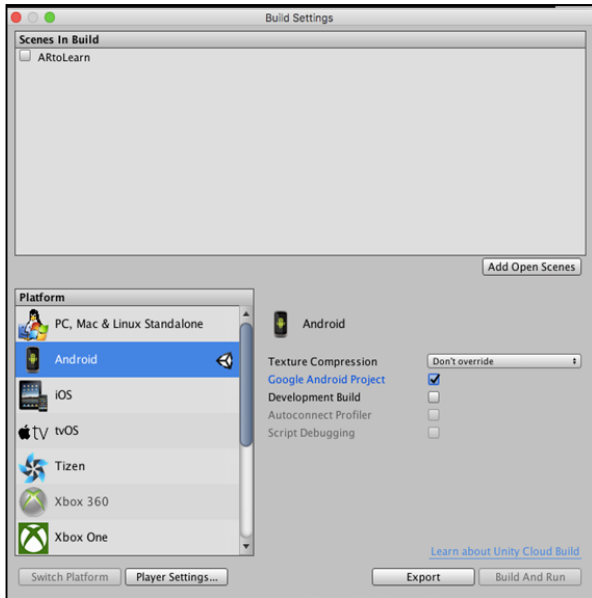


Fig. 10 Our Proposed main interface

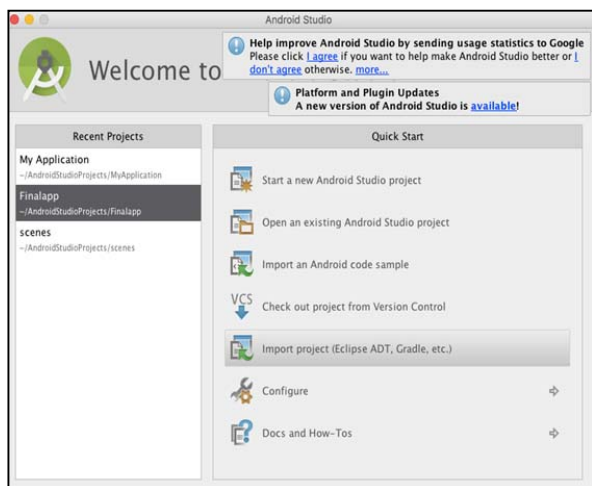
Using Android Studio software to develop our application, first we have to export the package of the project from Unity software. The four steps to import the Unity package in Android Studio are as shown in Fig. 11.



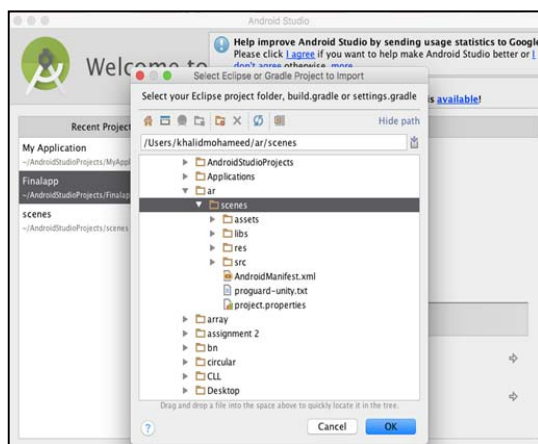
(a)



(b)



(c)



(d)

Fig. 11 The four steps of connecting Unity with Android Studio software

Step (a). to export the package, open a file, click on Build setting.

Step (b). select Android Studio then click the Export button.

Step (c). open Android Studio then click the Import project button.

Step (d). all the files of the package will appear, click OK.

All the targets uploaded in Vuforia are then download all together as a one package, this package called in Unity software to start to match each target (image) with the appropriate content. The system was developed in the Android version 2.2.3 environment, which is supported most devices. The main interface shows a list of options the user can interact with, these are Scan, Explore or About us, as shown in Fig. 12.

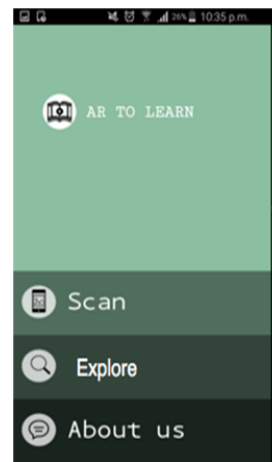


Fig. 12 The software application main interface

#### A. Scan Button

The scan button will open the camera ready for detecting and scanning the marker (Fig. 13). To display the content related to the marker, the user could scan multiple markers in the same session (no need to quit the application).

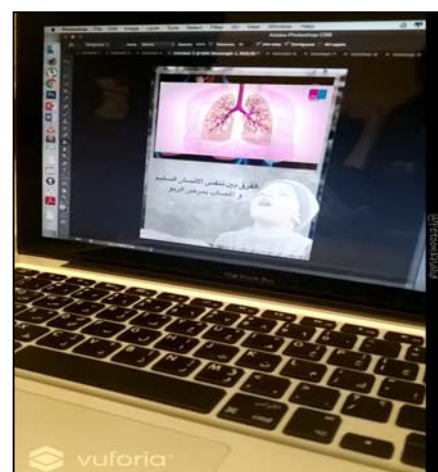


Fig. 13 The scanning interface

#### B. Explore

The explore button is useful to access all the videos that user may find it in the application's database without having

to use the AR to Learn book, see Fig. 14. (This is offered as an extra service to users).

[8] TutorialsPoint website. SDLC – Overview, 2017.



Fig. 14 The explore interface

### VIII.CONCLUSION

After research about AR in E-learning System, we found that a subject explained in several pages can be eliminated and replaced with a small marker. The proposed system aimed to provide a motivational environment to encourage people, especially students to learn more.

### ACKNOWLEDGMENT

Our thanks to those who contributed to the completion of this project, our sincere appreciation should be expressed to Dr. Dina Mahmoud, for her supervision, guidance and support throughout our project, and we would like to thanks the department of Information Technology in Qassim University for their help and support during the research.

### REFERENCES

- [1] V. Beglov, "Object information based on marker recognition": University of Eastern Finland, 2013.
- [2] B. MacIntyre, "Knowledge-based Augmented Reality for Maintenance Assistance (KARMA)", 1993.
- [3] Vallino. (1998). Introduction to Augmented Reality.
- [4] B. Furht, Handbook of augmented reality. New York, NY: Springer, 2011.
- [5] A. C. Estes, "Snapchat's New Lenses Feature Is Utterly Horrifying," ed: GIZMODO, 2015.
- [6] P. L.L.C. (2002-2015). *PDFill PDF Barcode*.
- [7] R. T. Azuma. (1997). A Survey of Augmented Reality.