Education and Knowledge Based Augmented Reality (AR)

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Abstract This paper gives a general idea about Augmented Reality (AR). It introduces AR and how it can be used to enhance the user and computer interface systems and turn it to an entertainment system. A sample AR system for teaching Arabic vocabulary Concepts to children in kindergarten will be represented in this paper too. Augmented Reality is a growing part of virtual reality area it is an integration of the real and virtual worlds. It considers as a part of a continuum of technologies. AR will change all computer process completely in future. Examples of using AR to accuse knowledge in general will be introduced too.

Keywords Augmented reality · Virtual reality · Language learning
E-learning

1 Augmented Reality Technology

Augmented Reality AR technology is used to overlay real images with data or digital images to increase impact, to increase usability, or to enhance understanding [1, 2]. AR is the real-time delivery of digital info to enhance or enable a geographical/physical experience [3].

Augmented Reality enhances a user's perception of and interaction with the real world. The virtual objects display information that the user cannot directly detect with his own senses. The information conveyed by the virtual objects helps a user perform real-world tasks. AR is aspic example of what calls Intelligence Amplication (IA): using the computer as a tool to make a task easier for a human to perform. Over the last several years, AR applications have become portable and widely available on mobile devices. Moreover, AR is becoming visible in our audio-visual media (e.g., news, entertainment, sports) and is beginning to enter

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other aspects of our lives (e.g., e-commerce, travel, marketing) in tangible and exciting ways [3].

AR is a lead of computer research that combines actual scenes viewed by user, and virtual scenes generated by the computer. This augments the scene with additional information [4].

AR is used to overlay real images with data or digital images to increase impact and increase usability or to enhance understanding [1]. It is also the real-time delivery of digital information to enhance or enable a geographical or physical experience [1].

The assertion that AR could provide enhanced learning experiences is grounded in two interdependent theoretical frameworks:

1. Situated learning theory.
2. Constructivist and Interpretivist learning theory.

Situated learning theory posits that all learning takes place within a specific context and the quality of the learning is a result of interactions among the people, places, objects, processes, and culture within and relative to that given context. Constructivist Interpretivist theories of learning assume that meaning is imposed by the individual rather than existing in the world independently.

The ultimate goal of AR is to create a virtual environment that is inter-active with the user where a user cannot tell the difference between the real world and the virtual augmentation of it. AR superimposes graphics, audio, and other sense enhancements from computer screens into real time environments. It also combines virtual reality and user reality seamlessly together [4].

1.1 Goals of Augmented Reality

The goal of Augmented Reality is to create a system in which the user cannot tell the difference between the real world and the virtual augmentation of it. Another goal of augmented reality is to add information and meaning to a real object or place. Unlike virtual reality, augmented reality does not create a simulation of reality. Instead, it takes a real object or space as the foundation and incorporates technologies that add contextual data to deepen a person's understanding of the subject. Creating virtual environment for a more rich user experience is another goal of AR. AR can be used to achieve feats which are limited in real world. and to enhance imagination of youths and children.

1.2 Augmented Reality (AR) Versus Virtual Reality (VR)

One of the biggest confusions in the world of augmented reality is the difference between augmented reality and virtual reality. Both are earning a lot of media

Table 1 Augmented reality (AR) versus virtual reality (VR)

Augmented reality (AR)	Virtual reality (VR)
System augments the real world scene	Totally immersive environment
User maintains sense of presence in real world	Visual sense are under control of system
Needs a mechanism to combine virtual and real worlds	

attention and are promising tremendous growth. Augmented reality (AR) is closely tied to virtual reality (VR), since the concept of AR evolved as an extension, or variation, of VR [5]. Augmented Reality (AR) is a variation of Virtual Environments (VE), or Virtual Reality as it is more commonly called (Table 1).

(VR) technologies completely immerse a user inside a synthetic environment. While immersed, the user cannot see the real world around him. In contrast, (AR) allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, rather than completely replacing it. Ideally, it would appear to the user that the virtual and real objects coexisted in the same space.

2 Augmented Reality Applications

AR represents the cutting edge of modern society's social-technological development. AR applications are being created by independent groups and organizations all over the world for use within many disparate ends and it can be used in all programming applications that interact with users. In this section some applications of Augmented Reality will be described in next sections:

2.1 AR and Education

In education, AR has been used to complement a standard curriculum. Text, graphics, video and audio were superimposed into a student's real time environment. Textbooks, ash cards and other educational reading material contained embedded markers or triggers that, when scanned by an AR device, produced supplementary information to the student rendered in a multimedia format [2, 3, 6, 7].

Benefits of Using AR in Education

- It provides rich contextual learning.
- Appeals to constructivist notions of education where students take control of their own learning.

- Provides opportunities for more authentic learning and appeals to multiple learning styles.
- Provides each student with his/her own unique discovery path. Engages a learner in ways that have never been possible.
- No real consequences if mistakes are made during skills training.
- Engage, stimulate, and motivate students to explore class materials from different angles [8].
- Help teach subjects where students could not feasibly gain real-world experience [9].
- Enhance collaboration between students and instructors and among students.
- Foster student creativity and imagination.
- Help students take control of their learning at their own pace and on their own path.
- Create an authentic learning environment suitable to various learning styles.

How Can AR Support Educational Process

Presentation [10] lists some points that illustrate how can AR support the education process which are:

Engages kinaesthetic learning

- Object manipulation: such as Turning page, Moving objects, Moving users head.
- Further interaction: like Combining objects, Re-arranging objects, Ani-mating objects.

Application of AR in Education and Desktop Applications

AR will change the process of education to entertainment (education with enjoying). AR can support education with many applications such as AR gaming, skills training, AR text books, discovery based books, leaning books and colour and modelling objects books [3].

The idea of AR text books: "In simple terms, AR allows digital content to be seamlessly overlaid and mixed into our perceptions of the real world. In addition to the 2D and 3D objects which many may expect, digital assets such as audio and video les, textual information, and even olfactory or tac-tile information can be incorporated into users perceptions of the real world. Collectively, these augmentations can serve to aid and enhance individuals knowledge and understanding of what is going on around them. Rather than seeming out of place, the digital markups inherent in AR lets users perceive the real world, along with added data, as a single, seamless environment. In other words [11] denes it as: "A MagicBook": it is a real book where markers have been added to the pages. This allows the traditional content of the pages to be enhanced with new 3D virtual content [11]. See Figs. 1 and 2.

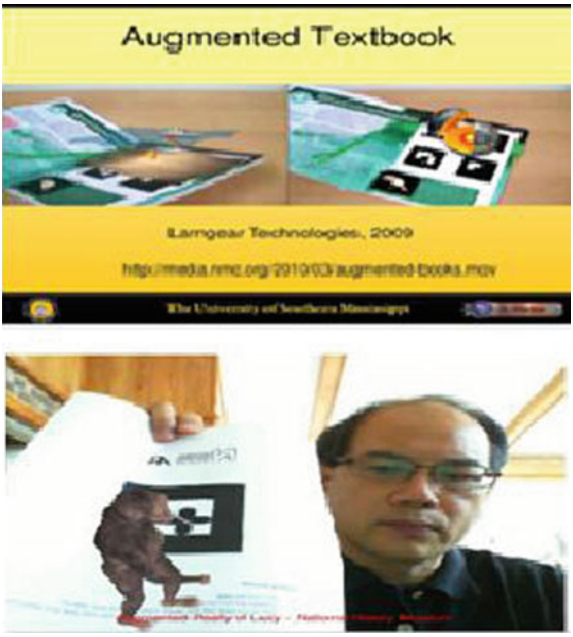

Fig. 1 A MagicBook an augmented reality text books

Fig. 2 Augmented reality education solar system. *Source* (https://www.youtube.com/watch?v=UkWuVVVUD4Q)

2.2 AR Web Application and Discovery-Based Learning

Augmentation is conventionally in real-time and in semantic context with environmental elements, such as sports scores on TV during a match. With the help of advanced AR technology (e.g. adding computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and digitally manipulable. Artificial information about the environment and its objects can be overlaid on the real world [weki].

AR Applications that convey information about a real-world place open the door for discovery-based learning. Currently, many historic sites supply overlay maps and different points of historic information for their visitors. However, in the near future, AR will bring even more excitement into historic sites though various developing projects. For example, the EU-funded iTacitus AR project (www.itacitus.org) will allow visitors to pan across a location while hearing and seeing a historic event play out. Another AR tool, the TAT Augmented ID application, will use facial recognition technology to display certain, pre-approved information about a person when s/he is viewed through the camera of a mobile device. A third tool, SREngine, will use AR object recognition to display information about everyday items in the real world, allowing for easy price comparison while shopping, as well as identifying plants and animals [6].

2.3 AR Medical Applications

There have been really interesting advances in medical application of augmented reality. Medical students use the technology to practice surgery in a controlled environment. Visualizations aid in explaining complex medical conditions to patients. Augmented reality can reduce the risk of an operation by giving the surgeon improved sensory perception. This technology can be combined with MRI or X-ray systems and bring everything into a single view for the surgeon Fig. 3.

Doctors could use Augmented Reality as a visualization and training aid for surgery. It may be possible to collect 3-D datasets of a patient in real time, using noninvasive sensors like Magnetic Resonance Imaging (MRI), Computed Tomography scans (CT), or ultrasound imaging. These datasets could then be rendered and combined in real time with a view of the real patient. In e ect, this would give a doctor "X-ray vision" inside a patient. This would be very useful during minimally invasive surgery, which reduces the trauma of an operation by using small incisions or no incisions at all. A problem with minimally invasive techniques is that they reduce the doctor's ability to see inside the patient, making surgery more di cult. AR technology could provide an internal view without the

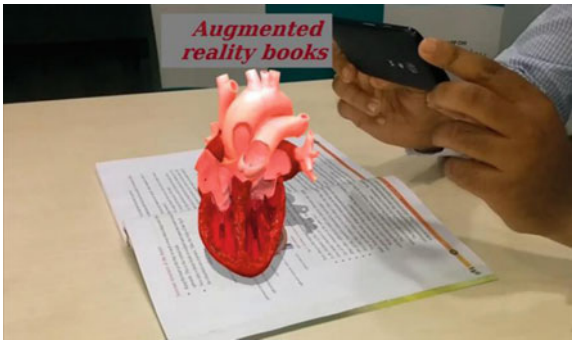

Fig. 3 Medical AR book. *Source* (http://press.mu-varna.bg/EN/augmenter-reality-medical-books/)

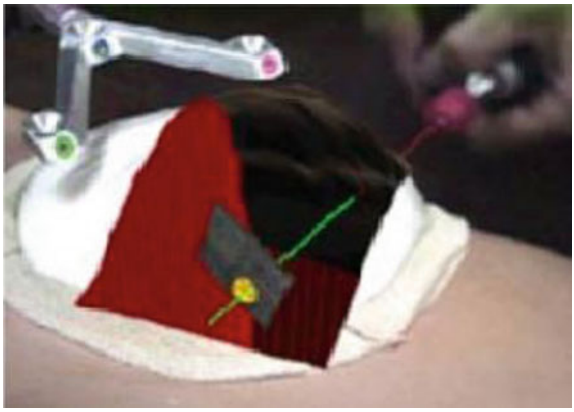

Fig. 4 Mockup of breast tumour biopsy. 3-D graphics guide needle insertion. *Source* (Courtesy UNC Chapel Hill Dept. of Computer Science)

need for larger incisions. AR might also be helpful for general medical visualization tasks in the surgical room. Surgeons can detect some features with the naked eye that they cannot see in MRI or CT scans, and vice-versa. AR would give surgeons access to both types of data simultaneously Fig. 4.

2.4 Military Training

AR can serve as a networked communication system that renders useful battle field data onto a soldier's goggles in real time. From the soldier's viewpoint, people and various objects can be marked with special indicators to warn of potential dangers. Virtual maps and 360 view camera imaging can also be rendered to aid a soldier's navigation and battle eld perspective, and this can be transmitted to military leaders at a remote command centre. And there is a lot of applications that can be made in military training like military aircraft and helicopter training where Head-Up Displays (HUDs) and Helmet-Mounted Sights (HMS) used to superimpose vector graphics upon the pilot's view of the real world Fig. 5 [2].

2.5 Annotation and Visualization Manufacturing, Maintenance, and Repair

Another category of Augmented Reality applications is the assembly, maintenance, and repair of complex machinery. Instructions might be easier to understand if they were available, not as manuals with text and pictures, but rather as 3-D drawings superimposed upon the actual equipment, showing step-by-step the tasks that need to be done and how to do them. These superimposed 3-D drawings can be animated, making the directions even more explicit Fig. 6.

2.6 *Engineering Design*

AR allowed industrial designers to experience a product's design and operation before completion. It also allows constructions engineers to test and visualize the building structure. AR interact with 3D models, animations, holograms and virtual environments in real time Fig. 7 [2].

Fig. 5 Augmented reality allows immersive experiences and analysis mixing real world and simulation

Fig. 6 Complex product development. *Source* http://www.advice-manufacturing.com/Virtual-and-Augmented-Reality.html)

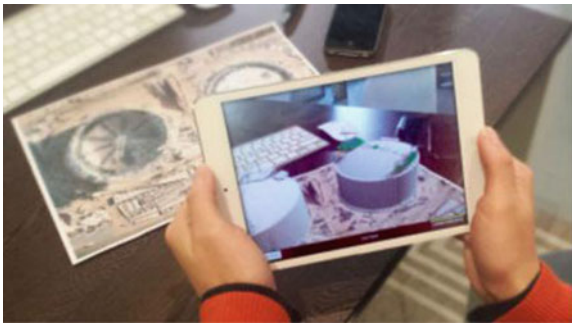

Fig. 7 Engineering design

Fig. 8 Wikitude

2.7 *Navigation*

Navigation applications are possibly the most natural t of augmented reality with our everyday lives. Enhanced GPS systems are using augmented reality to make it easier to get from point A to point B. Wikitude Drive for the Android operating system which is currently in beta brings the GPS into the 21st century. Using the phone's camera in combination with the GPS, the users see the selected route over the live view of what is in front of the car. it provides information from Wikipedia on a smartphone and the information displayed as markers on the camera screen. Geo-tagged Wikipedia "Wikitude" provides information from Wikipedia on a smartphone. The Wikitude can add digital content in the smart phone. This digital content can include information about different places Fig. 8.

2.8 *Google Latitude and Bright Kite*

Location-based social networking and microblogging Latitude Friends can see each other's Locations shown on map (on phone) Pro le/ photos included for each friend depends on each users privacy settings Fig. 9.

2.9 *Alive Journals*

Alive application is one of the leading Augmented Reality applications that has empowered more than 200 brands and publications including the very popular TOI to enrich their print content with new and innovative Aug-mented Reality experiences. It enables users to connect and engage with your print content by scanning, interacting and sharing their digital experiences which includes watching videos,

buying products, viewing 3D animations, photo gallery and much more. Alive is available on all platforms viz. iOS, Android, Windows, Blackberry, Symbian and Java see Fig. 10.

2.10 Alive Advertisement

Augmented reality can be used in advertisement to encourage customers to engage with their goods or services before purchase. This can form part of a companys marketing strategy where the aim is to identify and target a group of customers in order to satisfy their needs Fig. 11.

2.11 Smartphones Games and Application

The gaming industry embraced AR technology. A number of games were developed for prepared indoor environments, such as AR air hockey, Titans of Space,

Fig. 9 Google Latitude/Bright Kite

Fig. 10 Alive journals

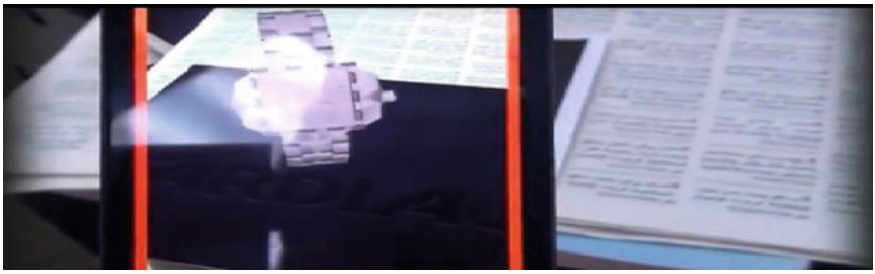

Fig. 11 Alive advertisement

collaborative combat against virtual enemies, and AR-enhanced pool-table games. Augmented reality allowed video game players to experience digital game play in a real world environment. Companies and platforms like Niantic and LyteShot emerged as major augmented reality gaming creators. Niantic is notable for releasing the record-breaking Pokmon Go game [2].

Pokmon Go, a game that has quickly captured everyone's attention and given them a reason to go out into the world, walk around, and catch Pokmon. The game uses GPS to mark your location, and move your in-game avatar, while your smartphone camera is used to show Pokmon in the real world. For the most part, it works, provided the game hasn't Crashed or frozen [12]. Pokmon dates back to the mid-1990s with popular video games, trading cards, comics, and videos featuring the Pokmon creatures (pocket monsters). The mobile game Pokmon GO, created by Niantic, was introduced in July, 2016, and is available on both iOS and Android devices. It was released initially in a limited number of countries, presumably so that Niantic could build up its infrastructure to support increased server tra c. The object of the game is to catch as many Pokmon as possible; there are some 150 available to date. When starting up the game, a map view of the players location is displayed, showing the players avatar and any Pokmon in the area. The presence of Pokmon depends on the location and the time of day. Clicking on a Pokmon switches the display to an AR view, with the creature overlaid on the live scene as captured by the players camera, see Fig. 12 [13].

2.12 Face Recognition and Personal Information Systems Using AR

Augmented reality and image recognition playing a big part in our computing future. Now the same tourist saw someone walking in the street and he want to know some information about him. All he had to do is to put mobile cam-era and focus on his face. The software will recognizes a face and displays the information needed such as name, age, relationship status. See Fig. 15a, b, c. [14], AR could integrate phone and email communication with context-aware overlays, manage

Fig. 12 Using AR in smartphone games. *Source* (http://www.digitaltrends.com/mobile/best-augmented-reality-apps/)

personal information related to specific locations or people, provide navigational guidance, and provide a unified control interface for all kinds of appliances in and around the home Fig. 13 [15].

2.13 Read Any Language

By this technology we can put mobile in front of any language text and ask it to translate to our mother Tung language. In Fig. 14 a tourist from England is visiting Spain and he try to read a picture which was written in Spanish. All he had to do is to de ne the source and the target languages and put the mobile in front of the picture. The picture automatically will be turned to his target language as in Fig. 14 [14].

Fig. 13 **a** Putting the mobile camera in the right position. **b** Focusing on the face, **c** Recognizing the face

3 Components of AR

Major components needed in order to make an augmented-reality system work.

3.1 Display and Tracking System

Display enables user to view superimposed graphics and text created by the system. The tracking system pinpoints the users location in reference to their surroundings and additionally tracks the users head and eye movements or Marker movement also.

Fig. 14 **a** Tacking a snap shot from the foreign language. **b** Translated by the AR application into the needed language

- Head-Up Display (HUDs).
- Head Mounted.
- Projection Display (HMPDs).
- Occlusion Display Head Mounted Display (HMDs).

3.2 Marker

Some Markers Shapes

Different types of Augmented Reality (AR) markers are images that can be detected by a camera and used with software as the location for virtual assets placed in a scene. Most are black and white, though colours can be used as long as the contrast between them can be properly recognized by a camera. Simple augmented reality markers can consist of one or more basic shapes made up of black squares against a white background. More elaborate markers can be created using simple images that are still read properly by a camera A camera is used with AR software to detect augmented reality markers as the location for virtual objects. The result is that an image can be viewed, even live, on a screen and digital assets are placed into the scene at the location of the markers. The simplest types of augmented reality markers are black and white images that consist of two-dimensional (2D) barcodes [16]. They are black and white most of time but they may be coloured in companies applications Figs. 15, 16 and 17 [17].

Fig. 15 Markers shapes

Fig. 16 Marker and how the system recognize it and display its related object on the mobile screen

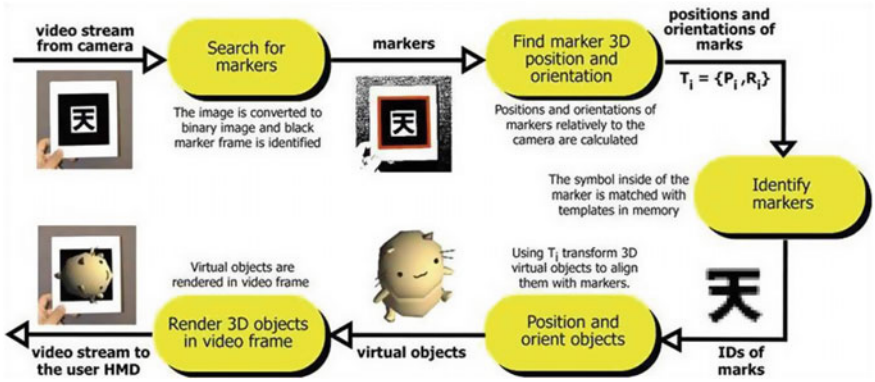

Fig. 17 ARToolKit process. *Source* http://hitl.washington.edu/people/tfurness/courses/inde543/READINGS-03/BILLINGHURST/MagicBook.pdf

3.3 Mobile Computing Power

Requires a highly mobile computer which superimposes the graphics and text created by the system over what is appears in reality Components of AR.

How does it work?

AR merges the three components (display, tracking system and mobile power) into a highly portable unit Research in the elds of computer vision, com-puter graphics,

and user interfaces are actively contributing to advances in augmented reality systems [4].

A special code is incorporated within a print ad and users place this ad in front of their webcam. The software recognizes the code and activates a reaction which could be in the form of a 3-D modelling of a product. It turns out that a 3D baseball player is standing on a baseball card users hold up to their webcam [4]. AR allows superimposing 3D-content/products into the real world. AR allows interaction with 3D-content at real time also [3].

4 Augmented Reality and Mobiles

4.1 Main Features [1]

- Works on every mobile phone with a camera, average screen and Visio capability.
- All content is secured.
- Does not require an application to be installed on the mobile device. Compatible with both Windows PCs and Mac computers.
- Content is encrypted to protect your brand.
- Fully packaged for massive instantaneous deployment.

Benefits [1]:

- Extend the experience with an innovative technology on your web site. Runs on nearly any computer with a webcam.
- Reduces times and cost of deployment through a web interface.
- Protect your brand with a powerful encryption mechanism.

4.2 Software Requirement

Augmented reality is sti ed by limitations in software and hardware. Cell phones require superb battery life, computational power, cameras and tracking sensors. For software, augmented reality requires a much more sophisticated arti cial intelligence and 3-D modelling applications [1]. It needs also [18]

- Image processing like (Opens).
- Graphics like (OpenGL).
- Audio (Penal).
- Toolkit like (A Toolkit).

4.3 Hardware Requirements

In terms of hardware components we need the following requirements at any AR application: Marker: It is two dimensional black and white squares have a speci c pattern. It is used to display the virtual objects above it, when it moves; the virtual object should move with it and appear exactly aligned with the marker. Web Camera: to capture video of the real world and sends it to the computer. Plasma screen Display: is a type of at panel display to display the virtual objects on it. HMD Display: it is called Head Mounted.

Display and it is a display device, worn on the head or as part of a helmet, that has a small display optic in front of one (monocular HMD) or each eye (binocular HMD). HMD Display: it is called Head Mounted Display and it is a display device, worn on the head or as part of a helmet, that has a small display optic in front of one (monocular HMD) or each eye (binocular HMD). Input Hardware Devices: it is a device which helps us to input values to computer such as mouse and keyboard.

Types of Toolkits:

1. OSGART (OpenSceneGraph AR toolkit): is a C++ cross-platform de-velopment library that simpli es the development of Augmented Reality applications by combining computer vision based tracking libraries (e.g. ARToolKit,) with the 3D graphics library OpenSceneGraph.
   It provide it's user with
   (a) all the features of OpenSceneGraph (high quality rendering, multiple le Format loaders)
   (b) interaction between markers.
2. NyARToolkit: is an ARToolkit class library released for virtual machines particularly those which host Java, C and Android.
3. ATOMIC Authoring ToolKit: a Cross-platform Authoring Tool software, for Augmented Reality Applications, which is a Front end for the AR-Toolkit library. It was developed for non-programmers, to create small and simple, Augmented Reality applications.
4. FLARToolKit: (FlashARToolKit) it is AS3 ported version of ARToolKit. Actually, is based on NyARToolkit, Java ported version of ARToolKit. FLARToolKit recognize the marker from input image. And calculate its orientation and position in 3D world. You should draw 3D graphics by your own. But helper classes for major ash 3D engines (Papervision3D, Away3D, Sandy, and Alternativa3D) are included. Papervision3D is used in starter-kit.
5. ARToolKit: ARToolKit applications allow virtual imagery to be superim-posed over live video of the environment. Although this appears magical, the secret is in the black squares used as tracking markers. The ARToolKit tracking works as follows: [19]

(a) The camera captures video of the environment and sends it to the computer.
(b) Software on the computer searches through each video frame for any square shapes.
(c) If a square is found, the software uses some mathematics to calculate the position of the camera relative to the black square.
(d) Once the position of the camera is known a computer graphics model is drawn from that same position.
(e) This model is drawn on top of the video of the real world and so appears attached to the square marker.
(f) The nal output is shown back in the handheld display, so when the user looks through the display they see graphics overlaid on the real world.

6. Augment is a mobile application that lets you visualize your 3D models in Augmented Reality, integrated in real time in their actual size and environment. Augment is the perfect Augmented Reality app to boost your sales and bring your print to life.
7. OpenSpace3D is a free and open-source platform, designed to create virtual and augmented reality applications and games.

5 Conclusions

Augmented Reality is a relatively new eld, where most of the research ef-forts have occurred in the past few years. In this paper some applications have been presented like using augmented reality in education, medicine, mil-itary training, engineering, gaming and much more applications on AR. Some applications presented too like face recognition and language translating.

Augmented reality opens the door for interactive learning and education. So the aim of this research is to give an explanation about the AR and how it can be used in education. And in the future how to design educational Arabic books which will be helpful and interesting in education especially for kids by translating the letters, words and sentences to an observed seen in the reality.

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