Augmented Reality Textbook for Future Blended Education

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Abstract: *The report presents an augmented reality textbook for future blended education. The efficiency of blended learning is discussed. The characteristics of augmented reality technology are described. An experimental augmented reality textbook for mechanical engineering students' blended training in the University of Ruse is presented.*

Key words: *augmented reality, blended learning, blended education, future education, virtual reality.*

INTRODUCTION

The training of the new generation students is a popular discussion theme [18]. Every teacher wants to use the appropriate mix of innovative training technologies and methodologies to attract today's students, and more important - to enhance the effectiveness of his training. Advantages and disadvantages of different innovative trainings as e-learning, mobile learning, virtual learning, etc., have been discussed in many papers and reports. But the important questions that still haven't found easy answers are: Which is the most effective training technology? How to reach and teach the new generation students more effectively? The best decision is to use effective combination solutions. For that reason blended learning has appeared. Blended education, hybrid learning - there are different names for this method. Blended learning combines different types of training technologies. Some of the most popular definitions are [1, 2]: "the combination of traditional learning and e-learning …", "the combination of media and tools for training …", "the combination of a number of pedagogics approaches…".

One other problem has to be discussed as well. Today's learners are "digital learners" [18] and do not prefer to read hard copy books. The new generation learners prefer to use e-learning books, because they do not want to read the whole book. They use a search engine with keywords to easy find what they need in the book. They prefer watching the movie than reading the whole book, because they haven't got the patience to wait until the end of the book. The hard copy books are not so attractive for the new generation learners. The little kids nowadays are born in the digital world and prefer interactive books which have more 3D effects and more visual effects, [18].

On the other hand, there are still learners, who prefer to read hard copy learning materials. They use the e-learning platform to watch movies, use Virtual 3D environments, download lectures, but they print them and prefer to read the textbooks without any computer devices - to keep their eyes and good health.

The augmented reality and its application for educational books are going to be presented in the paper. An experimental augmented reality textbook for mechanical engineering students' blended training at the University of Ruse is presented. The blended training presented combines traditional hard copy learning texts, e-learning lecture notes, mobile learning (using tablets), 3D learning models and augmented reality technology for more attractive educational books.

Augmented reality is a variation of virtual environments [3]. In the typical virtual reality environments the user cannot see the real world because he is immersed in the virtual world and the real world is completely replaced. In contrast, the augmented reality allows the users to see the real world supplemented with computer-generated information (3D virtual objects, digital text or photo, video, audio, etc). One of the advantages of the augmented reality is that the virtual and real objects coexist in the same space.

The main augmented reality characteristics can be summarized as follows [4]: 1) Blends real and virtual world, in a real environment; 2) Real-time interactive; 3) 3D environment; 4) Can apply to all senses, including touch, hearing, etc.

There are different approaches for augmented reality design. Some of them are expensive and use special devices - Head-Mounted Displays, Eyeglasses, Eye Tap, Handheld, Spatial, etc. Nowadays, the most popular one is the augmented reality with portable device displays (such as mobile phones, tablets or others portable devices). The displays are used for indirect view of a mixed (virtual and real) world (Fig. 1). The video-camera of the portable devices is used to capture the outside world and with the help of special software, virtual objects are superimposed onto the real video stream. Some augmented reality applications can remove real objects and replace them with virtual ones (remove the current building for new architecture plans).

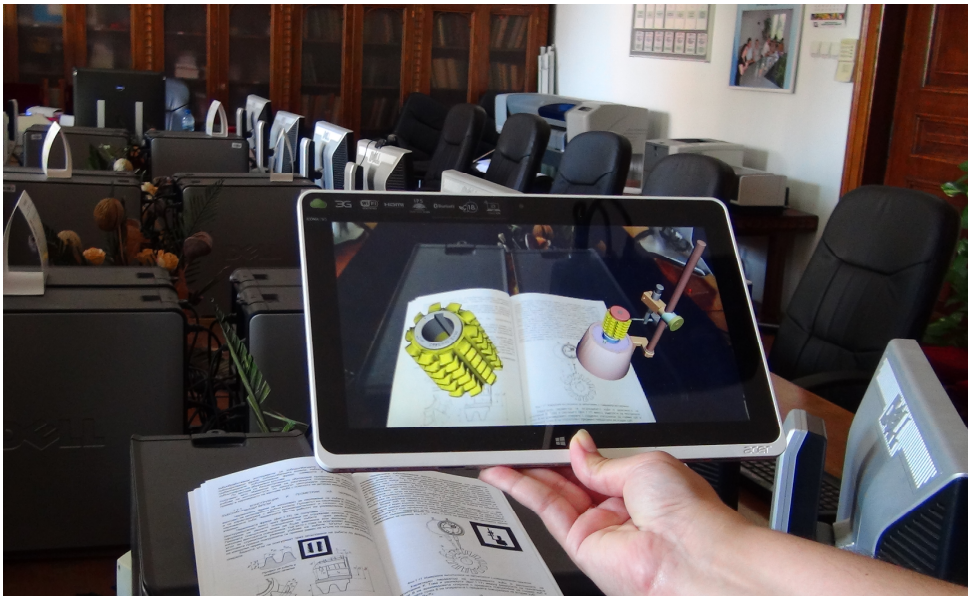

Fig. 1. Augmented Reality using tablet

AUGMENTED REALITY APPLICATIONS

In the architecture, augmented reality (AR) can generate a drawing of the existing structures and display virtual building structures directly on the building place. AR speeds up architectural work and assists in the design and verification of buildings. Using augmented reality, simulations of natural disasters can be carried out to track the response of the structures [7].

AR is used also in vehicle technology [8]. Windshields are replaced with high-resolution large screen displays on which useful data are displayed as maps, compass, alternative routes marked by arrows, weather and more.

AR technology is applied in the field of fashion. In clothing stores virtual dressing rooms with AR technology are deployed. The users of these virtual samples are given the opportunity to look around from different angles in front of the screen with mounted camera. The user uses input devices such as mouse and keyboard to choose available options for clothes. The computer adds the selected clothing over the user and displays it on the screen, [6].

In astronomy, AR is used for educational purposes and may indicate locations of stars and constellations in the foggy day or night, [9].

Travel agencies successfully use the possibilities of augmented reality to organize trips through mobile or desktop tools for augmented reality [11]. With these devices, tourists can get information about the current location, buildings, restaurants, hotels,

etc. The AR tool automatically starts multimedia presentations and performs 3D reconstruction of destroyed buildings [10].

In recent years, some surgical procedures are performed using augmented reality technology [12]. AR simulation is important to train surgeons for laparoscopic skills and to prevent unnecessary errors during surgery.

AR is used in interior design. Users can put a magazine with AR furniture on a place in their homes and using AR devices they have a virtual preview of the furniture in the room, [16].

AR can complement educational activities in different ways, [19]. 3D models, video, audio, text, etc. can appear onto learning books. By using an AR device, learners can interact with the book and have a more attractive view, [15].

AUGMENTED REALITY FOR MECHANICAL ENGINEERS BLENDED EDUCATION

Designing an AR interface uses two main principles: marker-based AR and markerless AR, [13, 14]. The most common form of marker-based AR uses QR-codes, but there are also marker-based AR with image recognition.

A marker-based AR is chosen for the realisation. A marker-based AR uses images that contain two-dimensional (2D) barcodes, which are detected by cameras. The markers for the experiment are going to be black and white. The coloured markers and image markers have some problems under different light of sources. Black and white markers are created for the experiment (Fig. 2).

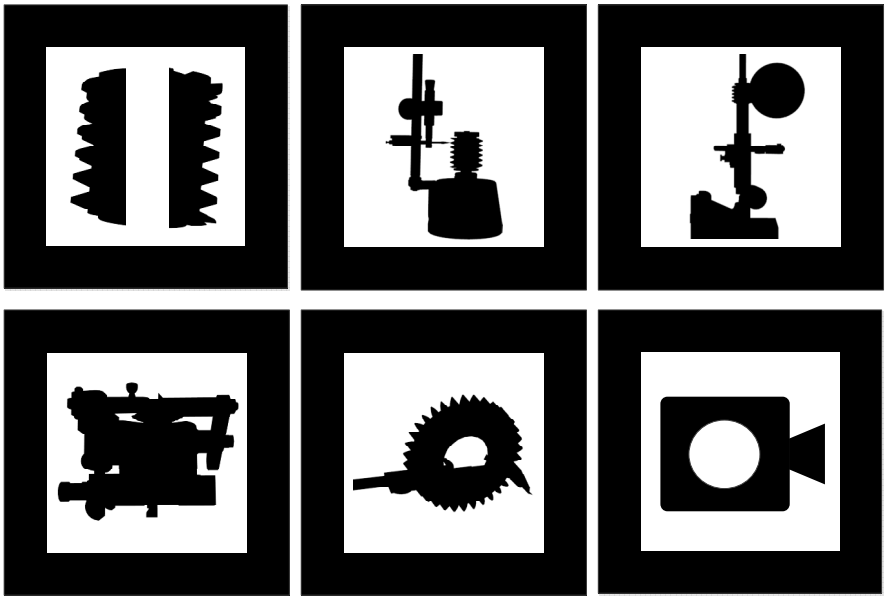

Fig. 2. Examples for black and white markers used for the experiment

3D virtual models for the mechanical engineers' blended education are created for the course Cutting Tools, [17]. Cutting Tools is a bachelor's degree course in the department of "Machine Tools and Manufacturing" in the University of Ruse. The main goal of the course is to teach the students about cutting tools design, geometry, technological capabilities and exploitation conditions. 3D models of the cutting tools are created to enrich the training with interactive realistic 3D visualizations and simulations of equipment installed in a real cutting tools laboratory.

Augmented reality with virtual 3D models of gear hob and a combined measuring tool are presented on Fig. 3. A 3D object appears when a marker is found. The learners can rotate the textbook and have more 3D realistic different points of view.

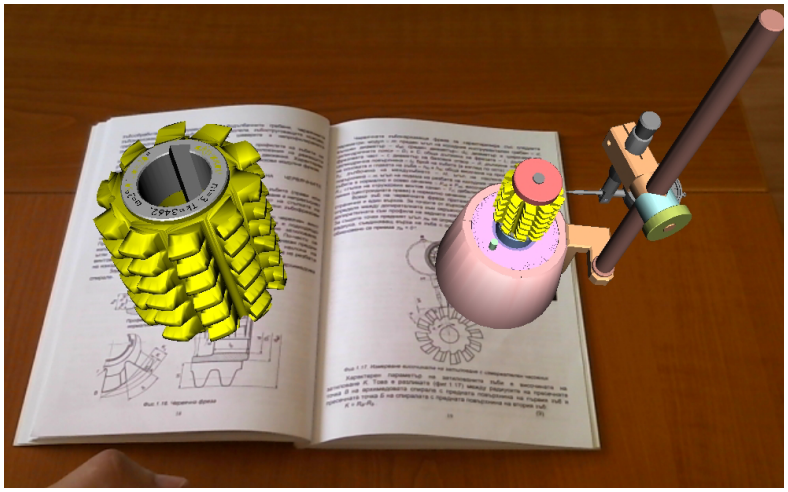

Fig.3. AR interactive textbook in Cutting tools with virtual 3D models of gear hob and a combined measuring tool

3D models are created for the whole cycle of 12 workshops. There are 3D models not only for cutting tools as Turning tools; Drilling tools; Reamers; Milling tools; Thread cutting tools; Broaches; Gear cutters; Hob Milling Cutters; etc., but also for the measuring instruments as Calipers (Fig. 4); Micrometers; Protractors; Gear Calipers and Combined measuring tools, machine tools as Tool&Cutter Grinding Machines and tool equipment as tool holding heads and holding devices (Fig. 5, Fig. 6).

Fig. 4. Measuring process of Disk Type Gear Shaper Cutter with Caliper

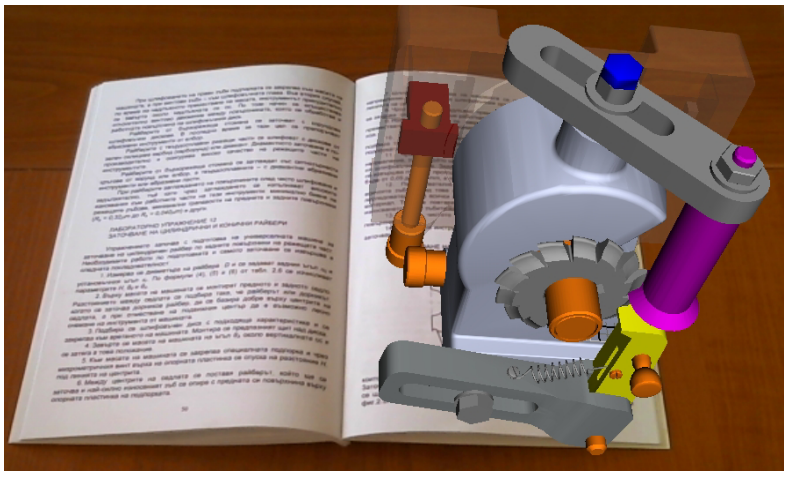

Fig. 5. Gear Cutter holding device for tool&cutter grinding machine

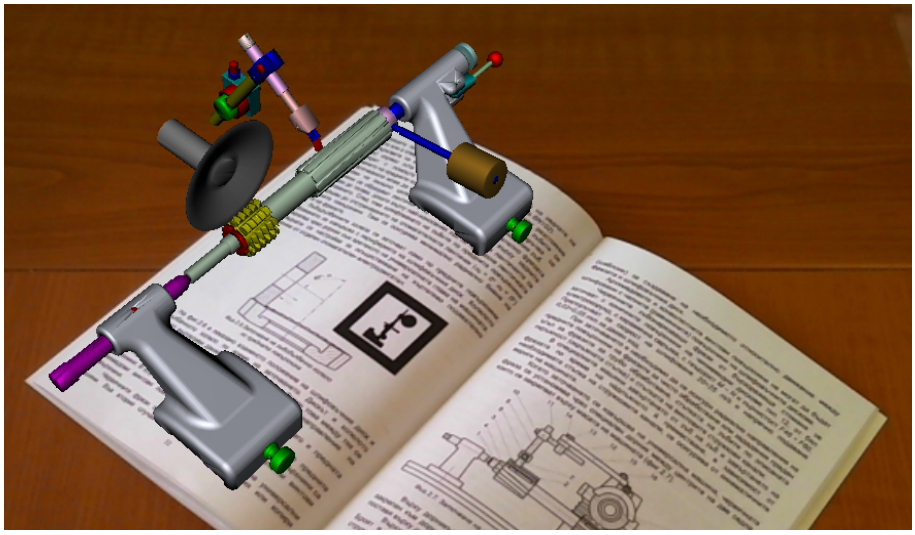

Fig. 6. Gear Hob holding device for tool&cutter grinding machine

Augmented reality technology can be used also for movies and animations. An animated movie with measuring process of a broach using caliper, micrometer and protractor is created. The movie can appear onto a marker in the printed learning materials as is shown on Fig. 7.

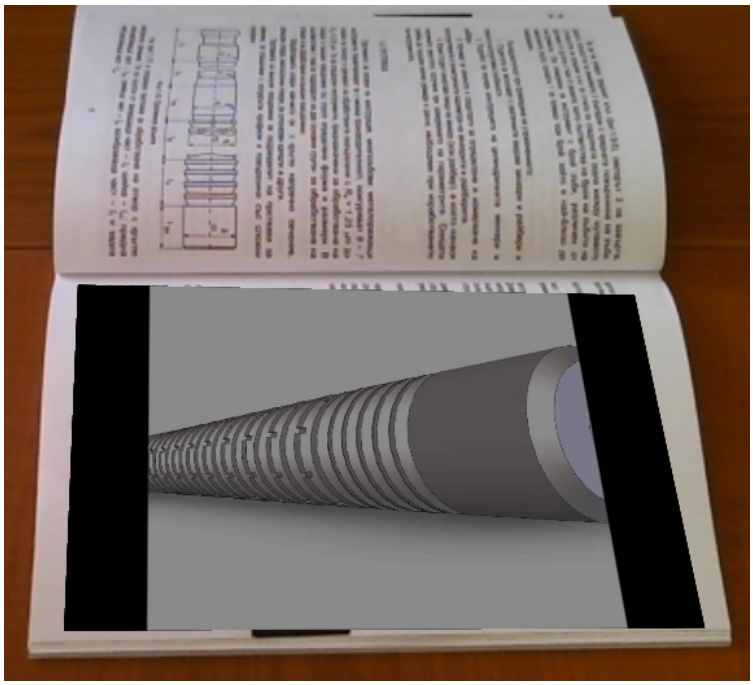

Fig. 7. AR interactive book in Cutting tools
with an animated movie of a broach measuring process

CONCLUSIONS AND FUTURE WORK

Traditional ways of educating students have well-proven advantages, but there are problems with keeping students involved and engaged without innovative technologies. Today students are new generation learners and the education must be relevant to their needs. They are born with technologies and prefer learning in the digital world.

Augmented reality interactive textbook in Cutting tools is designed for more attractive future blended education. Through the use of AR technology the lecture notes are turned into a new form of educational experience. Using their portable devices, students can find the markers in the lecture notes, recognize them and explore the 3D

models of the cutting tools. Next to the 2D figures in the lecture notes appears realistic 3D visualizations and simulations of equipment installed in the real laboratory, where the workshops in Cutting tools are conducted. Through the use of AR the books can become 3D animated environment.

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The paper has been reviewed.