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AUGMENTED REALITY - DEFINITION, DEVICES AND APPLICATION

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ABSTRACT
The technology of Augmented reality presents layers of information and images onto real objects. This article is targeted to research this technology. It is an attempt to prove that augmented reality is not just another fantastic and meaningless technology developed by a group of scientists, but it is an app that soon may become an integral part of our daily lives.

Key words: augmented reality, expanded reality,virtual reality, ICT, QR code.

1. DEFINITION OF THE BASIC CONCEPT

This work aims to study the technology of Augmented reality (AR) and show its applications.

Augmented reality is considered to be continuation of the well-known Virtual Reality (VR). AR connects the 'real environment' with the virtual.

Figure 1. Example of virtual reality

AR is defined as a direct or indirect observation of an image from the real environment, which is carried out in real time. To this image is added (expanded) additional, useful to the consumer information, pre-generated by a computer .(1)

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The technology of Augmented reality provides not only virtual information about the world around them, but also any indirect information, such as text, images, streaming live video. AR creates opportunities for increased experience and interaction of the users with the real world in real time.This is the difference between AR and the virtual reality technology or 'virtual environment', as called by Milgram, which immerses them in a synthetic and artificial world.

AR exceeds the potential of VR because it can be applied to all human senses, for example increasing the smell, touch and hearing. Therefore, according to Azuma and others (2), the future of AR technology will not be limited to certain types of display technologies, such as head-mounted display (HMD), which relies only on the user's vision as means of receiving information. One of the biggest advantages of the AR is its use of enhancing or replacing missing sensory perception in humans: increasing and adding additional sound signals for users with visual impairments or adding visual clues for users with hearing disorders.

2. HISTORY

The idea for AR (Augmented Reality) dates back to the 50s of last century, when the cameraman Morton Helling began to look for a more effective way of using cinema as an environment

that attracts spectators and affects all of their senses. In 1955 in his book "The Cinema of the Future" he described a prototype of his vision of the cinema. In 1962 he created such technology and called it Sensorama. This technology precedes the digital computing machine (the first prototype of the modern computer) (3).

In 1966, Ivan Sutherland invented displays that are mounted on a head (Head Mounted Display), and in 1968 for the first time in the world he uses them to create a system for AR (4).

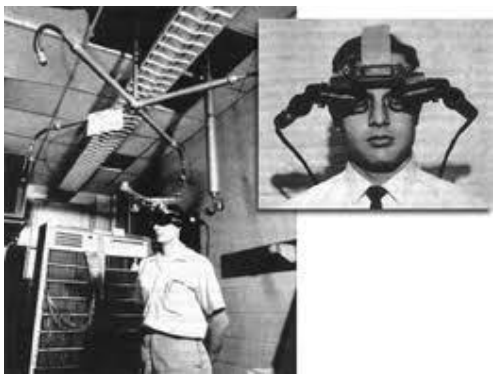

Figure 2. Head Mounted Display

In 1975, Myron Krueger creates Videoplace – a room that allows users to interact with virtual objects,already in real time. Later the engineers Tom Caudill and David Mizel from Boeing Company bring in the technology "augmented reality" in order to make collection of aircraft cables easier for the workers of the company.(1) These engineers used the modern name of this technology for the first time and started the discussion of the advantages of AR, for example its requirement of less energy due to the need of fewer pixels (4) compared to VR. In the same year L. Rosenberg developed one of the first operating systems for AR called virtual fixtures.

In 1997, Ronald Azuma began research in the theory of AR and defines it as a combination of real and virtual environment in which they together provide accessible and up to date information and image in real time (4). This definition is accepted from a wide range of specialists worldwide as a definition of AR.

An application of this technology is the first mobile game with AR- ARQuake, which was developed by Bruce Thomas in 2000 and shown at the International Symposium. In 2005, "Horizon Report" (5) predicts that the technology of AR will be developed even more in the next 4-5 years. These predictions come true the same year with the coming up of the technology of camera systems capable of analyzing the physical environment and objects in real time and correlate the position of the objects and the environment. More and more mobile apps for AR are expected to be developed in the future. In 2007 began the development of medical applications for AR, and in 2008 AR Wikitude Art Travel Guide was created . In the last few years, many systems are being developed ,such as the prototype of the sixth sense (MIT 6) and IPAD 2, Eee Pad, iPhone 4. All of them promise to revolutionize the market of mobile technologies using the technology of AR.

3. MAIN TECHNICAL DEVICES FOR AUGMENTED REALITY

The basic devices required for implementing the AR are: displays, input tracking devices and computers.

3.1. DISPLAYS

There are three main display types used in augmented reality: head-mounted displays (HMD); portable displays (mobile phones and tablets) and spatial displays.

a/ HMD is a display worn on the head or as part of a helmet or goggles . It projects images of both real and virtual environment in front of the eyes of the user.

Figure 3. Google glasses. Example of HMD.

b/ Portable displays – these are small computer devices with display that users can hold in their hands.

Figure 4. Portable Displays – personal digital assistant (PDA)

They use video surveillance technology, in which the captured image is layered over the real environment. Sensors are used for tracking coordinates and markers (digital compass and global positioning system (GPS). Example of this is the application ARToolKit.

Currently there are three different types of display devices available on the market that are capable of supporting augmented reality: smart phones, personal digital assistants (PDA) and tablets. (6)

Smart phones are portable and very popular. The latest innovations are combination of a powerful processor, camera, accelerometer, GPS, and digital compass. This turns smartphones into a very promising platform for augmented reality.
PDA's have many of the advantages and disadvantages of smart phones, but they are less common because the smart phone market has been revolutionized with the latest innovations in mobile technology: the operating system Google-Android and iPhones.

Tablets are much more powerful than smart phones, but they are larger and more expensive. They are also uncomfortable for long use with both hands and in the same time too heavy for one hand.

c/ The AR technology implemented with the assistance of spatial displays (SAR), uses video projectors, optical elements, holograms, radio frequency tags and other tracking technologies that graphically present the information directly on physical objects, without requiring the user to carry and use the portable display. Of course, these advantages of spatial displays expand the group of users because SAR enables a collaboration between different users of these technological devices. There is an increased interest about introducing AR systems to universities, laboratories, museums and the field of arts.

Figure 5. AR system using spatial displays

In this technology there is a large space between the users and real environment but spatial dispays bring them together through a combination of virtual and augmented. For example, projector-based spatial monitors can easily display images directly onto the surface of a physical object.

Table 1. *Comparison of the different techniques of projecting augmented reality*

Type of display	Advantages	Disadvantages
HMD- head-mounted displays	Full control over the displaying of the image. More natural perception of the real image. Best possible synchronization between virtual and real environments.	It is necessary for the user to use devices mounted on his head. Delays in displaying the image. Shaking of the virtual images.
Portable displays	High portability. Wide screen. Equipped with powerful processors, cameras, accelerometers, GPS, compass.	Higher price. Smaller size of the screen due to the reduced weight and the increased portability.
Spatial displays (SAR)	The entire system can be adapted to a PC in an office or a shop and it does not require purchase of additional equipment. Better perceived image by users. Projecting an image directly onto physical objects.	Does not support mobile systems. Not personal: all users in close distance can see the image (Nevertheless this disadvantage can become the greatest advantage of this type of display).

3.2 INPUT DEVICES

There are many types of input device systems used for augmented reality. The selection of an input device depends largely on the type of the application and also the type of the chosen display technology. A smart phone, for example, can be used as a pointing device just like the Google Sky Map. The user only needs to turn the phone towards the star or the planet he wants to know the name of and it will be shown on the display.

3.3. TRACKING

Tracking devices consist of digital cameras and / or other optical sensors, GPS, accelerometers, compasses, wireless sensors, etc. Each of these technologies has a different level of accuracy, and largely depends on the type of the developed AR system.

Table 2. *Characteristics of the different technologies used in AR systems*

Used technology	Range (in meters)	System preparations (in minutes)	Accuracy (in millimeters)	Mode (in seconds)	Environment
Optical sensors for marker detection	10	0	10	unlimited	Outdoors/indoors
Optical sensors for markerless detection	50	0-1	10	unlimited	Outdoors/indoors
GPS (radar)	unlimited	0	5,000	unlimited	Outdoors/indoors
GPS (wireless sensors)	100	10	1,000	unlimited	Outdoors/indoors

4. AN EXPERIMENT TO INCREASE THE TRAFFIC OF THE WEBSITE OF THE FACULTY OF ECONOMICS IN TRAKIA UNIVERSITY - STARA ZAGORA

In cooperation with the "Department of Informatics and mathematics" at Trakia University - Stara Zagora, we decided to research the success of such an application using QR Codes with augmented reality.

The objective: To see how the use of markers with QR code, containing added information about the university will change the Faculty's website traffic.

Target group - students and future ones.

Completed tasks:

1. The first most important step was to generate the QR code and the information that it would contain. There are many software programs for this purpose available on. All of them are free and extremely easy to use. The most popular ones are: www.goqr.me, www.qrstuff.com, http://qrcode.bg. Most suitable for our experiment was http://goqr.me/. The steps to generate a code are as follows: firstly, a suitable template is being chosen. We preferred "vcard", an interactive business card , which offers the option of adding full details about the faculty.
2. After selecting the template we started filling the boxes of information about the faculty. This is the second step of generating the QR code .

Box #1: Choosing a name – Faculty of Economics

Box #2: Name of the organization- Trakia University

Box #3: city - Stara Zagora

Box #4: address – University Town

Box #5: ZIP Code – 6000

Box #6 : phone number – +35942699405

Box #7: the most important part- the web page of the faculty- www.uni-sz.bg/sf

3. Step number 3 is to generate the code. In our case, we are being facilitated by the application. It generates the final result each time we add new information. We are required only to determine the size of the code.
4. The fourth step is the easiest. We download the genrated code to our computer.
5. Once the generated code is downloaded our next task is to choose the most suitable overall appearance of the marker.We decided for the marker to be simple but easiest to be understood by the users. A main requirement was putting tips on the marker to guide the users through the process of reading it.

The process of reading was divided into 4 steps,

Step #1: Starting the QR code reading application on the mobile device.

Step #2: Focusing the mobile device camera on the code which is located on the marker we want to read

Step #3: From the displayed information, we can click on the link which will take us to the faculty website

Step #4: Look at the contents of the page.

This is the finished look of the model:

Figure 6. QR code for the website of the Faculty of Economics, Trakia University - Stara Zagora

6. The third task is to print enough markers and spread them around. According to the statistics on the effectiveness of using QR codes and the statistics on the mobile market in Bulgaria, we expected the website traffic to increase by 20 to 43% of the average reported traffic for that period (m . Jul. 2011). The quantity of printed markers was 1,000 copies. Since the QR code is in black and white we selected a black and white marker. Thus the printing costs were reduced to a minimum. The size of the whole marker, which was chosen earlier, allowed for only 4 markers to be printed on a standard A4 size sheet of paper. In our case that would require 250 sheets at a standard price for the printing of 0.05 lev per sheet and printing paper -3 lev., the final cost was 15.05 lev.
7. The markers were sticked or spread around as flyers -at key points in the city: around schools, large supermarkets and downtown. With this social experiment we attracted the attention of both current and future students, and much of the younger population in the city.
8. Website traffic before and after scanning the markers

According to the administrator of the Web server of Trakia University ,the website traffic increased by about 24% in the period when the markers were spread. The current system does not report separately each subpage's traffic, but it is obvious that the use of QR codes as an entry to the web page of the Faculty has an impact on the website traffic.(7)

5. CONCLUSIONS

Augmented Reality (AR) is a new, progressive, modern and emerging technology that is successfully used for a variety of purposes: information, marketing, branding, advertising, entertainment, information about the places around us, etc. Considering the current trends in the mobile device market for smartphones, tablets and other devices that use apps for augmented reality, it will soon be vital to use QR codes in order to reach a targeted group of users. The example of the faculty website's traffic speaks clearly - a 24 % increase for a very low price and only for a few days.

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