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Augmented Reality as a methodology to development of learning in programming

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Abstract. The purpose of this document is to describe some of the areas where augmented reality is used, identify its components, structure and different forms of interaction with the user. As an example, some augmented reality applications oriented to education and others for different purposes, in addition to the pedagogical methods that work together to include the use of augmented reality as tool in support of learning, resulting in a series of advantages and disadvantages, disadvantages that with the advance of technology are projected to be surmountable. Among the different areas of study, we focused on the learning of programming, for being one of the subjects with more deficiency in academic results presented by students from different engineering careers. Based on this, we suggested to develop a tool that will serve as a complement in the learning of the programming and works in a collaborative and interactive way with the students, in addition to the material used by the teacher in classroom.

Keywords: Augmented Reality, computer science, programming, learning.

1 Introduction

Augmented Reality (AR) is a technology that increases reality with computer-generated images of two or three dimensions (CGI), objects and / or information, and allows users to interact with them [1]. RA is used today to facilitate certain tasks in different areas of study such as, learning, entertainment, maintenance, assembly, among others, of which we will focus on the component of learning. The general scheme of augmented reality is through the use of a technological device, which allows us to visualize different sources of information of a physical object within the real world with virtual components. While in virtual reality all its environment is virtual, forming together the mixed reality. We are in the era of technology where the highest percentage of students uses an electronic device such as; a smartphone, a tablet or a computer. Augmented reality is characterized for being a feature-based system: visualization, interactivity, communication, graphic representation three-dimensional and object recognition [2]. In addition, it plays a very important role in the development of different activities and tools that are integrate as a support for learning at different levels of study and areas of development [3]. Its implementation is not simple since there are many difficulties that are presented at the pedagogical

level, it is important to verify the enthusiasm of the students, the acceptance and adaptation in the use of space tools, which today is still used in many educational entities. Due to its dynamic content, it will always be more attractive for the student in any type of study, this leads to the fact that student is interested in the use of interactive tools that help in their learning process [4], the opinion of parents is an indicator of importance in the use of this type of tools specially for students of a basic level [5]. When applying the use of technology, we may take into account not only technological aspects, but the application of pedagogical methods. This would reduce the impact on the student's distraction and increase the commitment for a good use. Another important aspect to take into account is the degree of satisfaction of the students against the use of certain technology, in terms of the advantages and shortcomings that this may present, which would serve as a basis for building an effective learning tool in a future. The objective of this work is to present the characteristics and importance of the use of augmented reality and its different applications. As a learning tool, it is proposed to develop an application based on technology of Augmented Reality in the area of programming, which in the future will be evaluated by students of the same subject who know the operation and will show to those who do not know it. This will serve to improve characteristics of the tool or to generate new ideas.

2 Components and applications of Augmented Reality

Augmented Reality has several domains of use, identifying two large types of components or structures thereof. In this section we will see the components first and then a general review of the RA application.

2.1 RA Components

The general scheme of augmented reality is based on three components: the devices with camera, the software and the trigger or activator. With camera devices we have any kind of device ranging from a PC, mobile to a wearable. For software features, it is understood as any program that allow to make the necessary transformations to provide information additional that is required of the object captured by the camera. On the other hand, we have the triggers or activators, which are those formats of recognition to be treated as specifiers to the recognition of an object and they are used to link the printed content with the digital one. The Augmented Reality can be distinguished by two types, the one that employs markers or images and Augmented Reality based on position, and serve to locate and overlay a layer of information about points of interest, called POI (point of interest) of our environment, using GPS (Global Positioning Systems), accelerometers and compasses. For other part, we have augmented reality applications that employ markers or images which work with codes, which are nothing more than a way of representing information visually to allow its automatic reading, fast and without errors. Being the main difference between the different formats that exist, the way of representing the information and the amount of

data they can store. As the most used until today we have the QR codes (Quick Response), whose meaning is rapid response code, which is an evolution to the barcode, the QR is a two-dimensional bar code or 2D matrix, which was developed by Denso Wave Corporation in 1994 [6], which, being two-dimensional, they read the code in both directions and can contain up to 7,089 numbers, being able to include images within their code, are composed by three squares in the corners that allow the reader to detect the position of the QR code and a series of scattered squares that encode the alignment and synchronization (see Fig. 1). There are other types of markers which, like the QR are arrays of two-dimensional points, but can create as specific identifiers of an object (see Fig. 2). For the present work what is intended with these markers is that, if the user focuses on them using a device, the result is information of a 3D object superimposed from different angles, that present details or add-ons including multimedia applications.

Fig. 1. Structure of a code QR [7].

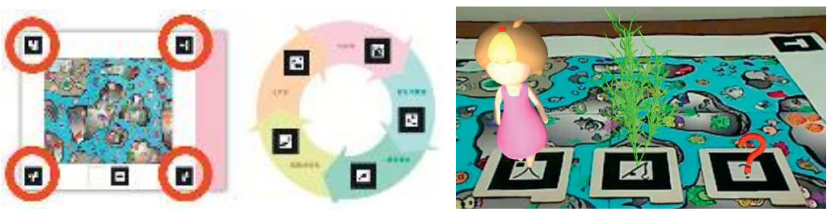

Fig. 2. Specific scoreboard [8].

2.2 Hardware and Software Features

Augmented reality works with hardware devices and components of software, which are developed together to form an application. In regards of the hardware, the central device used for reality increased its a camera, which can be included in any mobile device, being the most used cell phones, tablets, binoculars. As for software components, there are a lot of tools and applications, the most used are detailed below. At the level of operating system, we have Android and iOS, as another component we have the ARToolkit libraries, used to track video in real time of position and orientation of the camera regarding the activators. They use markers or labels for recognition, also uses the library Vuforia as platform or SDK development kit [1] as well as Metaio [9]. As another package of components we have JSARToolKit for applica-

tions of augmented reality with the Web along with HTML5, which serves to include multimedia functions and access to hardware, in this case the camera's user through the getUserMedia API. Regarding the use of multimedia, among the most used we have Unity3D, it's a game engine that can integrate with Vuforia [10] and 3D Studio Max for a complete 3D modeling, animation and rendering [11], and among the most important languages of java programming, javascript, C #.
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2.3 Applications with RA

There are applications with augmented reality that support the realization or analysis of different types of processes, we can mention some work done, for example, in the support in aircraft maintenance using mixed reality [12]. On the other hand, we have in the development of virtual prototypes in workplaces to simulate equipment management configurations that may result dangerous [13]. Tools which serve as guidance for technicians during courses of maintenance and training of industrial equipment [14]. Another area in identity verification, is by reconstructing the face of one person [15]. In addition to this as a tourist level, allowing the user recognize different data and aspects of a city [16], make trips and allow tourists explore new interesting sites according to the places they visit and be able to visualize interesting details in the environment [17]. On the other hand, it has used augmented reality in the reconstruction of objects, such as the reconstruction of objects of a church that was based on a historical and artistic analysis of historical monuments to reconstruct them at reproduce a visual impression close to the original [18]. Another type of interesting applications are the creation of a calendar in Tokyo, which has different technological applications from the use of reality increased, sensory interaction to the use of smell and different sounds by touching a calendar photo per month to review the features respective events that happen within the city, to be able to touch some of the photographs and feel the texture of the paths or tabs, as well as also smell the freshly cut grass, feel the touch and smell the glass in the photography and much more [19].

2.4 Use of RA in education

Augmented reality is being used in different areas of study, as a support to the learning process in a dynamic and interactive way, where the student can develop their skills visually and build your own knowledge There are several areas in which student uses as support tools implemented with reality increased, and in most cases have yielded positive results for their academic performance, making students feel more motivated, improve their level of knowledge and increase their skills to remember or memorize in shorter periods of time [20], there are several applications that can be they support the use of augmented reality in different areas of study, for instance in the area of computer science, medicine, architecture, history, among others (see Fig. 3).

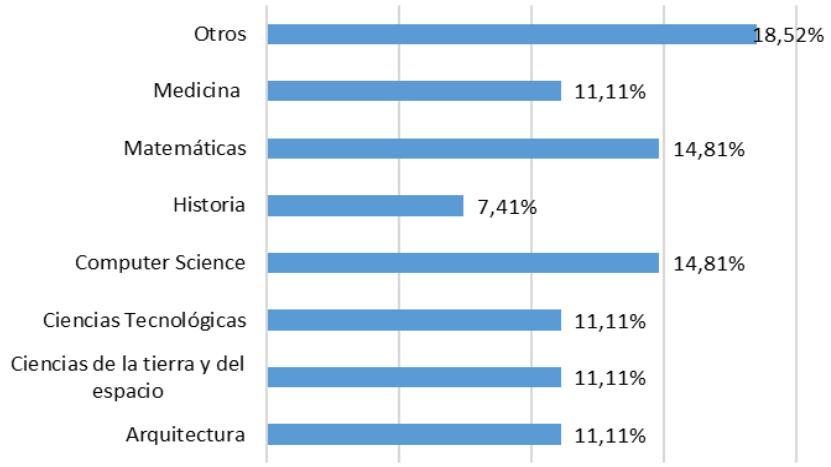

Fig. 3. Presents in general form according to indicated theory, the different types of subjects in which it is used augmented reality for education.

A Here are some examples of applications in which the use of augmented reality has benefited learning in different study areas. We can mention in the science area of the computing with an example of hardware component analysis for computer architecture [21]. Another example is in the use of ICTs [22], as well as the use of labels for different areas of computer science and technologies [23]. In the area of Architecture Applications have been made to improve the urban planning process [24] In addition to the use of augmented reality, there are tools that are applied to virtual reality in improving the design process in terms of the structural properties and the assembly of system components architectural [25]. The Augmented Reality technology in combination with the use of telephones Mobile offers many possibilities to evaluate, in situ, projects of architecture, urban design, construction processes and studies of the historical heritage. In the area of Earth and space sciences, they found applications for the geographical learning of a terrain by expanding objects in a book with RA [26]. In the agriculture for review of topics related to horticulture, gardening and landscaping [27] Several applications have implemented augmented reality with the application of concept maps, such as in the area of science at the primary level [28], as well as in the review of the day and night and the lunar phases. In the area of Technological Sciences in electricity is used in the ratio of the elements in an electrical circuit [29], another of the fields is where a test was carried out before and after the use of the RA and of traditional learning with very positive results [4]. Another are is in, History with applications that serve to a tourist and learning level, where the visitor acquires extensive and detailed knowledge of objects belonging to the built heritage of a city [30]. In the reconstruction of historic buildings [31]. In the area of mathematics for subarea of linear algebra, where the student can observe exercises of vectors through a game [32]. Augmented reality is used in different levels of study, and this is the reason why is used in primary level, applying in the study of numbers through a book of games

for preschoolers using an old literature, The Thirsty Crow [33]. Based on kinesthetic learning there are also applications like learning mathematical concept graphics and its derivations to obtain speed and acceleration depending on any position given by the user's movement [34], another of the scenarios is the development of teaching resources for students of Mathematics I of the Technological Institute of Monterrey [35]. In Medicine and subarea of anatomy for learning the human skeletal structure [36] and in radio therapy [37].

2.5 Benefits and disadvantages

The augmented reality for the learning process or education, can be seen in the works mentioned in the previous point, which have great potential because of their dynamic content, reinforcing the student learning to improve their skills when viewing objects stimulating their learning, not only individually but in a way collaborative Several results show that the use of devices with augmented reality improve the learning experiences of the students, resulting in important characteristics such as improving level of interest and enjoyment the use of tools [21], in addition, allows merging the real world with the virtual world for different areas of study, more and more educational institutions are using tools of interaction as support for learning, currently the future Teachers and students need to replace traditional methods of reading with an interactive 3D application as a positive influence on the educational process [38]. On the other hand, when talking about drawbacks, these can be presented at the software or hardware level, one of them being orientation of the camera to focus on objects [39], another is the ability of investment in technology by institutions and adaptability in teachers, versus the use of technology with traditional methods [28], we must take into account that students learn whenever the content interests them, that is why it depends to a large extent on the material and the presentation of the content. In general, some authors comment on their results that the use of a virtual environment usually causes a high level of distraction in students because the use of a device in class, often causes students to perform another type of task or have display problems because not all devices work Likewise for specifications in terms of hardware or software, this is why there are areas that require the presence of a guide that covers their concerns and work in conjunction with the tool, between one of the impacts is that the gender of a person has a dominant influence on the use of technology, in the case of the males, it has an advantage in terms of use of technological tools, which is not due to biological factors but social factors [40].

3 AR as a learning methodology

The level of learning of a student depends on a large extended of methods and functions that a tutor develops in the classroom to correctly guide a student or the type of tool that contributes to their learning autonomously, one of the techniques used today is gamification, for being one of the most interactive methods where the student learns through games giving very good results in the learning. The augmented reality

on the other hand, focuses on the dynamic interaction to perform different types of practical activities facilitate the learning process and the acquisition of knowledge of the students in the classroom. With the use of Augmented Reality, the Learning is done visually by interacting with images or multimedia contents that help to remember and memorize in the short term the proposed theme, others, are the use of conceptual maps of the contents of the subject, which help to synthesize and relate components [28]. On the other hand, the student develops a constructivist type of learning to whom interprets, elaborates, and experiences his learning. Constructivism is the basis of the use of the RA in reference to learning methods, and develops in different types, such as endogenous constructivism that emphasizes the importance of the apprentice's exploration during learning, the exogenous constructivism with a strong emphasis on students who build actively represent their own representation of knowledge with materials such as, instruction sheets and guidelines, and dialectical constructivism where the student interacts with other students and with the support of a teacher in materials such as; debate sessions, use of social networks, among others [40]. Direct experiences with the use of augmented reality allow the student to visualize closely elements that are not available in a physics with 3D format, which facilitates access to knowledge of different ways, improving traditional methods, but we still cannot leave totally isolated the traditional methodology, but on the contrary complement it with technology, through the use of textbooks, maps conceptual concepts, prototypes, specific locations and more. The RA components facilitate student access complementary concepts to expand information related to the subject or content of a subject, between activities or projects, which allows each student to continue to deepen in what is indicated or is find interested Typically tutors will find different benefits of the use of augmented reality according to the objectives of its exhibition, as well as in the development of activities or projects, being this type of technology adaptable to the requirements and needs of users. (see Fig. 4).

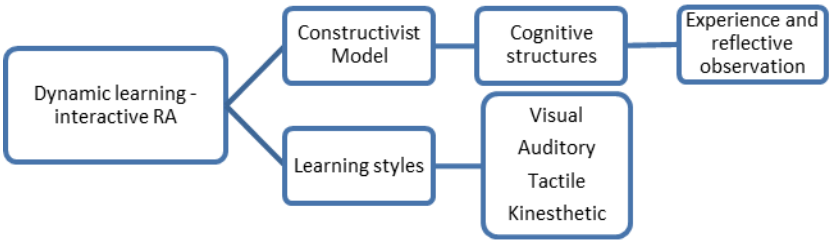

Fig. 4. Summarizes the fundamental characteristics that benefit the learning process through the use of augmented reality.

3.1 Types of interaction in education

There are different physical and behavioral phenomena that influence the interaction of a user versus the use of technology, as well as different dynamic forms of the user in their interaction with reality increased, starting with the main types of interaction,

first in the educational area, which mostly through books or conceptual maps where the images are the fundamental axis with which, the student visualizes the characteristics of the object through the identification of the same by means of QR codes or personalized codes that are captured by a camera and incorporate multimedia applications to include sound, videos, images and to be able to review in detail a set of characteristics and contents that help support learning by medium of interactions, for example, the Gagak application [41], which develops the concept of virtual book with augmented reality, this type of interaction is based on its majority to Billinghurst's Magic Book [42]. Another type of interaction are outside of the educational environment, such as in museums to observe geological objects, paintings, historical monuments. In the cities, the view of different buildings that makes up a cultural heritage and it turns as a tourist learning guide, in universities, to identify the campus or locations of different areas. In the marketing area, the user can interact with the product and review its details. The different forms of interaction are extended until you interact with kinesthetic components, used for physical activities in place to listen or visualize, for example the Kinect tool, a Motion detection device, equipped with camera, sensor infrared depth detection, microphone and a dedicated processor [43], and the type of interaction to verify step by step the assembly process of equipment or maintenance [44].

4 AR in learning programming

The importance of learning to program opens a world of possibilities. There are several tools that help you learn how to program. These characteristics and development are detailed of a programming learning tool by using RA.

4.1 Importance of programming

In education refers the subject of Fundamentals of Programming as one of the most questioned in different areas of engineering, due to the results obtained in the students. One of the topics outlined by students in general is the difficulty in establish a logic in the development of algorithms from the management of control structures, loops, functions, the use of parameters and the scope of the variables [45], to the handling of events in the programming object oriented. Many of the causes of this problem is the lack of motivation, the use of different learning styles, knowledge previous in programming, and on the contrary to this, students who have experience in programming, which can cause a high degree of competitiveness compare to other students, leading this to the fact that, the other students may lose interest and as a consequence the teacher has to take the content of the subject. Most technologies are developed based on a programming language, for this reason it has become a challenge that at a very young age there are different means and techniques to improve and support the learning of programming.

4.2 Applications in the area of programming

The current learning in the field of programming, especially in the object-oriented, has led to execute different learning methods, but determining the effectiveness requires an analysis that evaluate the results regarding its use, there are support tools that can go hand by hand with the guidance of a teacher or instructor, we talk about a new paradigm of programming called "Real Word Programming (RWP) ", where the user develops their own applications, specifying actions and conditions in the real world without using a computer desktop [46], and this is where most applications are headed. Among the most used tools today we have Scratch Community Blocks, which allows children to access, analyze and visualize code execution by dragging understandable commands to their level of knowledge and see the corresponding animation [47], other derivatives such as Minecraft [48] and Snap [49], another example is the educational robot Thymio for administration of events, where students through a tablet are reviewing in real time the executed event of the robot, which helps the student to have programming logic in terms of handling events [50]. Currently, there are different types of tools to support the learning of programming, as well as continue researching to improve them by conducting tests and studies, such is the case of the Beling.co website, which aims to facilitate learning basic programming for Indonesian teenagers from a fun way [51]

Fig. 5. Examples of Tools to learn to program. Scratch, Minecraft and Snap.

4.3 AR design proposal for learning the programming

The authors are working on a prototype that exploits the benefits of AR in education for learning programming. Although, even prototype is in a very initial version, we want to present in this section the general idea of it. Therefore, it is proposed to de-

velop a tool that cooperates interactively with the student in the process of learning using augmented reality technology, for this, The student MUST have a device at his disposal " a mobile", which with a web camera recognizes the labels that are immersed in the programming algorithm and help to visualize the detail of the algorithm components by using of multimedia, in later use the recognition of text that in this case would be the algorithm code to decipher as an interpreter of commands, and incorporate the interaction in terms of questions you can request the student through the same platform, this would be through utilities provided by artificial intelligence systems, taking as input data questions recorded by students and how output data simulation of the code used. (see Fig. 6).

Fig. 6. General scheme of system development of augmented reality for learning programming.

5 Conclusions

The augmented reality has shown so far to be one of the pioneering technologies in supporting learning in different areas of study, it has been presented in several applications, the same that given positive results as well as a series of disadvantages in different approaches, which are expected to be resolved in a future. Between one of the areas we focus on programming, due to its great performance for the creation of different applications that are used Daily by users with different purposes. That is why the research will serve to improve and collaborate in the realization of a tool capable of complementing the learning of programming in the classroom, which would be of great interest to those wish to be part of the programming world. We look forward to presenting the development of this tool with the purpose of generating satisfactory results in support for programming learning techniques.

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