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Visualyzart Project - The Role In Education

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Abstract

The VisualYzARt project intends to develop research on mobile platforms, web and social scenarios in order to bring augmented reality and natural interaction for the general public, aiming to study and validate the adequacy of YVision platform in various fields of activity such as digital arts, design, education, culture and leisure. The VisualYzARt project members analysed the components available in YVision platform and are defining new ones that allow the creation of applications to a chosen activity, effectively adding a new language to the domain YVision. In this paper we will present the role of the Instituto Politécnico de Santarém which falls into the field of education.
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Keywords: Augmented Reality; Natural User Interfaces; Education; Yvision;

1. Introduction

In this paper we will introduce the VisualYzARt project. Having as aim to develop a platform that can be used to make the augmented reality and natural interaction ubiquitous in the world, it intends to develop research on mobile platforms, web and social scenarios in order to bring augmented reality and natural interaction for the general public. This project is a consortium of four Higher Education Institutions (HEI) and the mentor company YDreams. Each one of the HEI analyse the components available in YVision and define new ones that allow the creation of applications in the chosen activity, effectively adding a new language to the domain YVision. To this end the partners intend to organize activities and dissemination materials for the YVision platform appropriated for their peers. In a first moment each one of the partners involved have studied and validate the adequacy of YVision platform in the their field of activity, i.e. digital arts, design, education, culture and leisure, and propose AR and NUI

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applications to be created with YVision. In this paper we will focus on the role of the Instituto Politécnico de Santarém (IPS) which falls into the field of education.

2. Augmented Reality and Natural User Interfaces in Education

The concepts of Augmented Reality (AR) and Natural User Interfaces (NUI) are not new, although they are still considered to be emerging technologies, and sometimes, their definitions are even overlapped. Therefore, in a first moment, there is the need to distinguish them. When it comes to AR, the term is credited to Tom Caudell in 1990, who has used it to *"describe a digital display used by aircraft electricians that blended virtual graphics onto a physical reality"* (Cassella, 2009), but when it comes to the definition of AR applied to computer sciences the definitions have some little variations, being defined as a *"technology that allows computer-generated virtual imagery information to be overlaid onto live direct or indirect real-world environment in real-time"* (Lee, 2012:31); or as an *"emerging form of experience in which the Real World (RW) in enhanced by computer-generated content tied to specific locations and/or activities"* (Yeun & Yaoyuneyong, 2011:119); it can also be related with the *"Addition of a computer-assisted contextual layer of information over the real world, creating a reality that is enhanced or augmented"* (Johnson, Smith, Willis, Levine & Haywood, 2011:16); or even seen as the possibility of *"blending (augmenting) virtual data - information, rich media, and even life action - with what we see in the real world, for the purpose of enhancing information we can perceive with our senses"* (Johnson, Smith, Levine & Haywood, 2010:21). Bearing in mind all these definitions, we can say that augmented reality is the technology that allows computer-generated content to complement real-world environments, by blending a contextual layer of information over 3D spaces. As for the definition of Natural User Interface (NUI), Liu states it as *"an emerging computer interaction methodology which focuses on human abilities such as touch, vision, voice, motion and higher cognitive functions such as expression, perception and recall"* (Liu, 2010:204). According to the NMC *"Natural user interfaces allow users to engage in virtual activities with movements similar to what they would use in the real world, manipulating content intuitively"*. By these definitions, we can infer that, NUI allows us to interact with virtual tools in a natural way, through our touch, vision, voice, motion, expressions, etc., making it possible to manipulate content intuitively. As these two concepts refer of means that improve real and virtual content and the ways of obtaining it, sometimes they become intertwined. But it is important to understand that, even though they can complement each other, they are different methodologies. One referring to enhancing real-world information by adding a virtual layer; and the other using natural forms of communication to interact with technological tools. They both have potential to education, as they can be used to enhance the way we interact with technological tools and the way we view and perceive that information.

2.1. Role in Education

The use of AR for educational purposes is seen as one of the most promising methodologies. In fact, according to Horizon Report *"Augmented reality was the Advisory Board's highest rated topic for 2011, which is a testament to its increasing importance within higher education"* (Johnson, Smith, Willis, Levine & Haywood, 2011:16). Taking into account that AR overlays virtual data into the real world, it can be used for visual and interactive forms of learning by simulating dynamic processes and these *"Dynamic processes, extensive datasets, and objects too large or too small to be manipulated can be brought into a student's personal space at a scale and in a form easy to understand and work with"* (Johnson, Smith, Willis, Levine & Haywood, 2011:17). Thus it can be used in all classrooms, enhancing any subject, and especially helping with abstract or complex subjects, sometimes hard to visualise and therefore more difficult to understand. By having experiences they could not have in real world and have contact and manipulate 2D and 3D synthetic objects, it would help to develop practices and knowledge, and this can only possible through AR (Wu, Lee, Chang & Liang, 2013). It is having this in mind that AR is not only regarded as crucial within Higher Education, but also viewed as possible to introduce even within elementary school, while introducing abstract concepts to children. According with Garden (2005), AR offers the possibility to expand learning outside of the classroom, with mobile applications that make possible for students to access data in loco about the place where they are, or about what they are looking at. Therefore *"augmented reality has the potential to move learning out of the classrooms and into the spaces where students live. Encouraging informal*

learning that is easily accessible may prove particularly effective in engaging students, extending learning to spaces that might help them form connections with content, the locations that provide the context for it, and the peers that they share it with" (Garden, 2005:2). In fact, it is possible to view mobile-AR as a subarea of AR, as it enables a whole range of new possibilities by making pervasive AR systems possible. Rather than having to use several devices *"pervasive AR systems run on handheld computers with location-registered technology (e.g., Global Positioning System [GPS]). Pervasive or mobile-AR systems are less obtrusive with a focus on real environments."* (Wu et al., 2013:43) For example, Google Sky Map allows you to point the camera of a cell phone to the sky and identify the stars, constellations and planets (Lata, 2013). Besides the 3D appeal, AR technology is able to react to real-life objects, space, landmarks, ancient civilizations artefacts, allows us to observe a realistic representation of an object, brings books 'alive', and enables students to virtually dissect bodies, manipulate and change objects (Myers, 2012). Hence, creating diversified possibilities for education, giving students more control of content manipulation and creation, the capability to interact with real world objects, otherwise out of reach, access via cell phone to information about space, historical places and objects, thus making possible for learning to occur in real world contexts - situated learning (Veneble, 2011). As for NUI within education, this is viewed as highly interesting methodology, as it permits to interact with technology in a natural way, allowing to have *"systems that understand gestures, facial expressions, and their nuances, as well as the convergence of gesture-sensing technology with voice recognition, which allows users to interact in an almost natural fashion, with gesture, expression, and voice communicating their intentions to devices"* (Johnson, Adams, Cummins & Estrada, 2012:18). Hence, in a pedagogical point of view AR and NUI, both show potential to engage and stimulate students in a different way than traditional methodologies. Not only because it involves the technology students feel drawn to, but because it offers students the chance to visualize things they could not in real life, helps to view things in different points of view or helps them to do experiments not possible otherwise, giving them opportunity to have first-hand experiences and allowing them to retain knowledge otherwise would only be abstract. Also promising aspects of these methodologies are collaboration (due to the underlying interactive environments and the stimulating dynamic processes it requires), creativity and imagination (being innovative and technologically stimulating) and situated learning (as it allows students to find connections between real life and education, due to the additional virtual contextual layer). All these aspects contribute to make a difference in students' way of learning by helping them develop skills and knowledge more effectively (El Sayed, Zayed & Sharawy, 2011). Research shows that AR and NUI contribute to the development of skills such as organization, searching and evaluating information, helping them to acquire better investigation skills that are crucial in today's information-base society. Furthermore, when these skills come together with the motivation these methodologies allow, it may help students develop more accurate knowledge on a specific topic. Additionally, these methodologies can make a difference with learning difficulties students, providing visualization, manipulation and immersion they can improve the way these students acquire learning. As stated by Wu et al *"Although so far a majority of AR systems have been developed for teaching science and mathematics because these learning subjects require visualization of abstract concepts, there were also a few systems designed for students with special needs and language learning."* (Wu, Lee, Chang & Liang, 2013:46).

2.2. *Challenges in Education*

Despite their promising improvements, there are still some downsides to the large use of these methodologies, for they require still expensive technology, and are often technically complex to work with. Also, these methodologies differ from the teacher-centred, conventional teaching methods, being possible to find some resistance among teachers. On the other hand *"students in AR environments may be cognitively overloaded by the large amount of information they encounter, the multiple technological devices they are required to use, and the complex tasks they have to complete"* (Wu, et al., 2013:41). This also needs to be addressed by the teachers, focussing students on what is their goal, and in giving them competencies to be able to summarize what they learn. Also the same authors point out that new challenges arise for educators, as they are required to also use these methodologies and tools. But this is where applications such as Yvision can change everything, as they make possible to create visually, without extensive knowledge of programming, contents that you would like to teach.

Hence, when it comes to the pedagogical issues, as it happens with all innovative methodologies, it may find some resistance among teachers, requiring more participatory approaches than traditional teaching does. Also these are student-centered instructional approaches, diverging from the teacher-centered, delivery-based traditional teaching methods (Wu, Lee, Chang & Liang, 2013:47). To disrupt from tradition is not always easy or consensual. Nowadays students seem to be more independent as learners, once they have access since early childhood to technological devices and to all kind of online tools and services. Therefore, solutions of AR and NUI seem to be suitable for students, despite the resistance of some teachers and even some educational institutions. Regarding the technological issues, to prepare for the usage of AR or NUI involves acquiring new equipment, which is quite expensive, since it is cutting-edge technology, such as head mounted-displays or AR glasses. Also, not all educators are technologically savvy to use these devices, and may need some training to work with and maintain them. Which is why it is important to present solutions user friendly and that doesn't require a deep learning curve. It is taking into account the pedagogical and technological gaps that need to be addressed, that applications such as YVision can help, by making possible to create visually, without extensive knowledge of programming, contents for education. In topic 4 we present some possible concepts to be created with YVision, under the supervision of IPS.

3. VisualYzARt project and Yvision technology

The aim of VisualYzARt project is to develop a platform that can be used to make AR and NUI accessible to the wider public, by developing research in mobile, web and social platforms. It is our belief that only with good, inclusive and broader tools that allow multidisciplinarity it will be possible to brig AR and NUI into our daily life. The VisualYzARt project is being developed under a specific technology named YVision, a component-based framework that allows the development of complex systems based on pre-built modules, which are controlled by behaviour trees. These architectural concepts have been validated by the gaming industry and are now widely used in the development of complex end products. As mentioned before, the project is a consortium of four HEI and a private company. The HEI are asked to perform exploratory experiments in order to find the potential of AR and NUI in their scientific fields using YVision as a tool - initially programmed through its DSL Code, and later, in the second year of the project, through its visual programming tool. Each of these entities will thus be the YVision propellant within his scientific and academic community, in the extent that will:

- define the criteria for the operation and usability essential and important for your day-to-day, which will be considered by the team in its YVision concrete investigation;
- creating proof of concept of the use of YVision that demonstrate the efficiency and enrich their work through the use of this technology;
- disseminate the YVision within their academic and professional communities.

The project is divided into five main technological fields or topics of research: (i) visual programming tool for NUI and AR; (ii) NUI and AR in embedded systems; (iii) NUI and AR in social environments; (iv) conceptual proofs to exploit the innovative capabilities of YVision; (v) development of YVision communities. Each of these research topics will be developed throughout specific activities: study, design and specification, experimentation, testing and evaluation, dissemination and management of Intellectual Property. This succession of activities is adapted from the stages of the scientific method and the software development cycle. From the multiplication of the research themes by the activities arise the project's tasks at a macro level. In an operational management point of view it is intended to pursue an agile, incremental and interactive methodology allowing an investigation by the various competing groups involved, with integration moments, scheduled according to the dependency set for the tasks and respecting the milestones and critical paths of the project.

4. Instituto Politécnico de Santarém - educational concepts

In VisualYzARt project and taking into consideration the important role of methodologies such as AR and NUI, the Polytechnic Institute of Santarém is proposing some applications to be built and tested, in order to bring the mentioned methodologies into the classrooms. Considering the existence of tutoring degrees in our institution, and

the possibility of contact with not only higher education (HE) students but also grammar school students, the following concepts for applications are being outlined.

For HE students, applications that allow:

- Geometry – to manipulate, deconstruct, plan, measure volume, area, project shadows, show plan in 3D. This may require virtual glasses once it can enable more than one person to be working in the same solid.
- Art – to shape objects in 3D with hand movements, for art classes. The teacher or students will be able to choose or import a geometric solid to work on. The solid should respond to manipulation with gesture (The file should be able to be imported into a 3D printer, so that the sculpture could be printed as an object).
- Chemical Formulas, biology and biochemical elements – (i) to visualize, manipulate and construct formulas and chemical elements, molecules and atoms (Drag and drop, 3D, Gestures); (ii) to combine elements and predict reactions. (Reactions will be visible and make changes in the virtual layer); (iii) to take a picture of compound to find out what it is and its composition, as well as possible applications.

For Grammar School students, applications that allow:

- Mathematics – to solve problems where they can see a reaction. The student reads the mathematical problem, types in the solution and he can see a character responding to the solution and then letting the student know if he is right or wrong.
- History – to create Portugal History books with 3D animations of historical key moments. For those who do not have AR Glasses, tablet or a cell phone the book will have normal illustrations. The books will have a marker and QR code that will allow students to see the animations.
- Science – to compare the scale of the universe in 3D, in a classroom, using hand gestures to interact with the model.
- All areas - with a cell phone or tablet to point it to a flower, animal, tree, leave, etc. and recognize what it his characteristics. The teacher will have to upload an image or photo of an object and then add the extra informational layer. This will require the teacher to prepare the class in advance.

5. Final Considerations

The kick-off of the project started with a workshop involving the various partners in order to determine a baseline policy, which will guide the research to be undertaken. Here, the survey will be made of the specific needs that should guide the various areas of research, and can begin to be outlined conceptual proofs which will also help to frame such research. In the particular development of conceptual proofs, understood as subprojects, will be adopted a methodology for operational management scrum. Augmented Reality (AR) facilitates the perception of information by the user. This perception of contents is made in a natural way by the user because it is displayed within its context. The Natural User Interfaces (NUI) focusing on the natural interaction makes possible to the user to manipulate in a natural way, data and digital systems. The merge of these technologies results in a powerful and engaging experience. The possibility to specify, design and develop these systems in a graphical way is essential for creative people to handle the complexity and multidisciplinary of these systems, allowing the creation of complex virtual worlds and enriching experiences. Good tools and a multi-disciplinary community will make it possible to bring augmented reality and natural interaction to our daily lives.

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