

Augmented Reality Applied in the Amazon as a Way of Promoting Culture, Tourism and Education in the Most Remote Places

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Abstract— Artistic education is essential for the integral development of students, as it allows them to explore creativity, express emotions and develop cognitive skills. The implementation of augmented reality in public schools has the potential to transform the artistic learning experience. By providing access to a wide range of artworks, technology helps overcome geographic and financial barriers that often limit students' exposure to art. Furthermore, augmented reality offers additional resources, such as contextual information about the works, artists' history and interactive elements, which enrich students' understanding and engagement. Technology offers a new perspective on art education, allowing students to explore, experiment and engage with works of art in ways never before imagined. In this context, augmented reality emerges as a promising technology, allowing works of art to be viewed and interacted with in a virtual environment, without the need to physically visit a museum.

Index Terms— Augmented Reality, Works of Art, Financial Limitations, Technology

I. INTRODUCTION

In a historical context, the idea of applying virtual elements to the real world dates back to the 1960s and 1970s, with the first experiments in research laboratories. Since then, Augmented Reality (AR) has emerged in a context of constant technological advancement and the search for new ways of interacting with the digital world.

However, it was with the emergence of smartphones and the launch of the Pokémon Go application in 2016 that AR became widely known and accessible to the general public [1]. The game, which used the camera and geolocation of mobile devices to superimpose virtual creatures onto the physical environment, won over millions of users around the world and showed the potential of this technology.

Since then, AR has expanded beyond games and infiltrated different areas, such as education, medicine, design, tourism, advertising and much more. Renowned companies, such as Apple, Google, Microsoft and Facebook, have invested heavily in the area, developing platforms, in addition to several specific devices for AR.

Another important milestone was the launch of smart glasses, such as Google Glass and Microsoft's HoloLens, which allow virtual elements to be viewed in a more immersive and natural way [2]. These technological advances have opened doors for the development of more sophisticated applications, ranging from simulating complex training to creating interactive experiences in museums and cultural events.

With the rapid advancement of Augmented Reality (AR),

we are witnessing a revolution in the way we interact with the world around us. Technology has established itself as a powerful tool, overcoming entertainment barriers and impacting different sectors of society.

In the area of education, AR has been used to enrich the learning experience of students. Through compatible applications and devices, it is possible to offer interactive and immersive content, allowing students to explore abstract concepts in a practical and visually stimulating way. Additionally, AR has been used to create laboratory simulations, enabling safe and accessible virtual experiments.

In medicine, Augmented Reality has proven to be an ally in the training of healthcare professionals. Surgeons can view vital information in real time during complex procedures, facilitating decision-making and reducing risk. Furthermore, AR has been applied in the development of personalized prosthetics and in the rehabilitation of patients, promoting a more efficient recovery.

In the field of design, AR has revolutionized the way projects are conceived and presented. Architects and engineers can view three-dimensional models of full-scale buildings, allowing a better understanding of the space and making it easier to identify potential problems before construction even begins. In the fashion and decoration industry, AR allows consumers to virtually try on clothes and objects in their real environment, before making a purchase.

The tourism sector has also benefited from AR applications. Visitors to museums and historic sites can access additional information about works of art or monuments by pointing their devices at them. Additionally,

AR has been used to create immersive virtual tour experiences, allowing people to explore distant locations without leaving home.

Advertising has also embraced Augmented Reality as a way to engage the public in innovative ways. Companies use technology to create interactive advertisements, in which consumers can view products in their own home before purchasing them, trying on different colors, sizes and styles.

With the constant improvement of AR and the emergence of new applications, we can expect a future that is increasingly integrated between the physical and virtual worlds. Augmented Reality will continue to expand its horizons, transforming the way we work, learn, play and interact with the environment around us.

II. METHODOLOGY

The research was exploratory, with the aim of investigating the feasibility and effectiveness of developing an Augmented Reality (AR) application capable of rendering a 3D image from a tag.

Competitor research and market analysis played a key role in the development of our scientific paper on creating an augmented reality app for viewing 3D artwork. These steps allowed for an in-depth understanding of the existing landscape and provided valuable insights for the design and implementation of our own application.

Competitor research was conducted with the aim of identifying other similar applications available on the market. Aspects such as functionalities, user experience, quality of 3D models and interaction resources were analyzed. This research allowed us to understand existing solutions, their strengths and weaknesses, as well as the gaps we could fill with our own application.

Market analysis was carried out to assess demand and trends in the field of augmented reality applied to the visualization of works of art. We investigated public interest, user needs and expectations regarding an application of this type. We also look at market potential, including the number of potential users, sectors where augmented reality is already used, and opportunities for growth.

The application of augmented reality at the São Paulo Museum of Art (MASP) has proven to be an innovative and engaging way of enriching visitors' experience. Augmented reality technology, combining virtual elements with the real environment, has been used to offer an interactive and immersive approach to the works of art displayed in the museum.

One of the main applications of augmented reality at MASP is the possibility of viewing additional information about works of art through mobile devices, such as smartphones or tablets [3]. Visitors can use specific applications developed by the museum to scan the paintings and thus gain access to detailed information about each work, such as its history, cultural context, techniques used and

biographies of the artists. This enriched experience allows for a deeper and more contextualized understanding of the pieces, expanding visitors' knowledge.

Another strong inspiration was the use of augmented reality at the Latvian National Museum of Art, which has transformed the way visitors interact with the museum's collections and exhibitions [4]. Augmented reality technology has been used to provide immersive and enriching experiences that combine the virtual world with the real world, bringing new perspectives to works of art.

One of the most notable applications of augmented reality in the museum is the creation of guided virtual tours [5]. Using mobile devices, visitors can access museum-specific applications that use augmented reality to provide detailed information about the works of art on display. By pointing the device at a particular part, visitors are able to view additional information such as historical data, technical details, critical interpretations and even explanatory videos or audio. This allows for a personalized and interactive experience, where visitors can explore the works at their own pace and immerse themselves in relevant information.

After all this research and analysis, we chose Vuforia, which is an integration of Unity, as the platform for developing our project. Additionally, Vuforia Unity integration offers a set of pre-made tools and components that simplify the AR app development process. Unity provides an intuitive and user-friendly interface for configuring image trackers, markers, and virtual objects within the development environment. This streamlines the AR app creation process and allows developers to focus more on creating engaging user experiences.

III. RESULTS

Getting into development, we import the Vuforia package into Unity and the database we created when uploading the target images. Once the imports were done, we started adding the Vuforia components. First, three "target_images" were added, and we assigned a painting to each, and within each "target_image", we added the 3D objects that would be rendered respectively when scanning the images.

For each component, we positioned both the target image and the 3D object horizontally, where the 3D object would be on top of the target image, and adjusted the scales to not exceed the maximum screen size. At this point we already had a functional mobile application, and when the targets were identified, the 3D object was rendered.

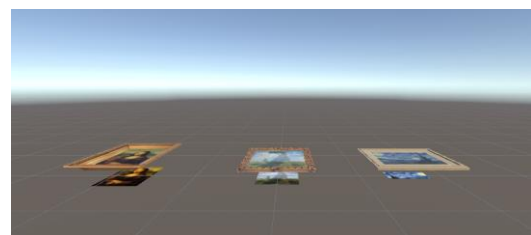


Fig. 1: Final position of targets and 3D objects

It was also thought that to monetize the project, advertisements would be present in the application, so we added a button component from Unity itself to the project, and inside we added an image with the advertising companies. We created a script with the C# language for the "OnClick" event and assigned the function we call "OpenUrlClick" to the button so that when clicking on the button, the user would be redirected to the advertised website/product. This advertisement was permanently positioned below the camera screen.



Fig. 2: Advertising used in the application

And to make it more interactive and educational, we added a description for each target image. To perform this task, a Unity component "plan" was used, which we call "Switch", to alternate the description. For each target we used the "OnTargetFound" event and assigned a script made in C# that we called "SwitchImage" to all targets, and to differentiate them we just changed the parameter sent, so we could know exactly what work was on screen. And once the painting is identified, a new description is rendered, with painting data, such as: author, year of creation and context.

Mona Lisa, Leonardo da Vinci
Mona Lisa, também conhecida como A Gioconda (em italiano: La Gioconda, a sorridente) ou ainda Mona Lisa del Giocondo (Senhora Lisa esposa de Giocondo) é a mais notável e conhecida obra de Leonardo da Vinci, um dos mais eminentes homens do Renascimento Italiano.

Fig. 3: Example of a description of the work Monalisa

In the end, we created a build for Android and IOS, and only obtained the binary ".apk" file for Android, and the application was made available for Android devices, and it can be downloaded from the project's Github, where it is currently located in its version 1.2 [8].

In the IOS environment we had problems generating the ".ipa" binary file, as we did not have access to a device that could compile the code in the Xcode IDE [9].

However, we obtained a functional application that uses Augmented Reality (AR) to display works in an interactive, fun way that provides information for those who do not have enough resources to go to an international exhibition.



Fig. 4: Screenshot of the running application

IV. DISCUSSION

Augmented Reality (AR) has proven to be a promising and fascinating technology, with countless applications and potential benefits in various sectors. Furthermore, with the development of the application, we realized the potential to impact society in different ways. The application can contribute to the democratization of knowledge, making information and experiences accessible to a wider audience [10]. And with AR we can also explore other fields in the future, where improving efficiency and safety in industrial environments, enabling more accurate medical diagnoses and facilitating communication and collaboration between remote teams, are options evaluated in the near future.

However, it is important to consider potential negative impacts such as addiction to AR games, distraction in real-world situations, and privacy issues related to personal data collection [11].

During our studies for the development of the App, we realized that Augmented Reality has been a very popular subject and development platforms have started to look more and more at this industry. One of the main development platforms for creating Augmented Reality applications is Unity [12].

Unity is a game development engine that has expanded beyond this domain, becoming a popular choice for developing interactive applications in different areas, including AR. Its flexibility, advanced features, and large developer community make Unity a robust and versatile option for creating AR applications [13].

Unity's integration with tools like Vuforia, mentioned in the article, allows you to create AR experiences in a relatively accessible and extremely productive way. Vuforia is an image development and recognition platform from the company PTC, which provides capabilities for image tracking and

marker detection, essential for implementing virtual objects in real time.

With the combination of Unity and Vuforia, developers have a powerful combination of tools at their disposal to create high-quality AR applications [14].

Finally, it is also worth discussing the challenges faced by Augmented Reality. The technology is still constantly evolving and faces technical and adoption hurdles. Creating AR experiences involves integrating hardware, software, and interaction design smoothly, which can be complex. Furthermore, the lack of affordable and easy-to-use AR-specific devices may limit its large-scale adoption [15].

Another challenge is to ensure that AR is developed ethically and responsibly, considering aspects such as security, privacy and inclusion. In short, Augmented Reality is an exciting technology that offers diverse opportunities. Its practical application covers several sectors, with significant impacts on society. However, technical, adoption and ethical challenges must be addressed so that AR can be widely used in a safe and beneficial way

V. BACKGROUND

Augmented Reality (AR) has emerged as an innovative technology that combines virtual elements with the physical environment, providing an immersive experience for users. In recent years, its use has expanded significantly in several areas, including entertainment, education, medicine and industry. AR's ability to overlay digital information onto the real world has aroused considerable interest among both researchers and developers, due to the potential for transformation it presents in various fields.

Regarding the current state of knowledge, it reflects a remarkable evolution, driven by significant advances in hardware and software, as well as interdisciplinary research in several areas.

Understanding the fundamentals of human perception, combined with developments in computer graphics and artificial intelligence, has enabled the creation of increasingly immersive and realistic AR experiences.

Furthermore, the emergence of high-powered wearable devices, such as smartphones and smart glasses, has expanded the reach of AR, making it more accessible and easier to use.

At the same time, studies on human-computer interaction have contributed to the understanding of how to design intuitive and engaging AR interfaces, promoting a more natural integration between the digital world and the physical world.

VI. CONCLUSION

Augmented Reality has experienced exponential growth and is transforming the way we interact with the world around us. This project explored several areas where AR has been successfully applied. In education, for example, AR enriches

students' learning experience by offering interactive content and laboratory simulations.

The methodology used in this study was exploratory, aiming to investigate the feasibility and effectiveness of developing an application using AR. Using the Vuforia platform, integrated with Unity, simplified the development process, providing pre-made tools and components for creating engaging user experiences.

The results showed the creation of the application that uses tags as target images to render 3D objects. Additionally, advertisements and descriptions of the target paintings were added, making the experience more interactive, educational and enabling monetization of the application.

In conclusion, AR is revolutionizing the interaction between the physical and virtual worlds. With its rapid advancement and the emergence of new applications, we can expect an increasingly integrated future, where AR will continue to positively impact areas such as education, medicine, design, tourism and advertising, providing immersive and enriching experiences.

REFERENCES

- [1] "RA+ já disponível em Pokémon GO!" Pokémon GO. <https://pokemongolive.com/post/arplus/> (consult. 2023-06-07).
- [2] "Microsoft HoloLens" Microsoft. <https://www.microsoft.com/pt-br/hololens> (consult. 2023-06-07)
- [3] "MASP ÁUDIOS". MASP. <https://masp.org.br/audios> (consult. 2023-06-07).
- [4] "Latvian National Museum of Art - Art Museums". Mākslas muzeji. <https://www.lnmm.lv/en/latvian-national-museum-of-art> (consult. 2023-06-07).
- [5] MISUGI, Guilherme; DE ALMENDRA FREITAS, Cinthia Obladen; EFING, Antônio Carlos. Releitura da privacidade diante das novas tecnologias: realidade aumentada, reconhecimento facial e Internet das coisas. *Revista Jurídica Cesumar-Mestrado*, v. 16, n. 2, p. 427-453, 2016.
- [6] "Vuforia Developer Portal - Database". Home | Engine Developer Portal. <https://developer.vuforia.com/vui/develop/databases> (consult. 2023-06-07).
- [7] "Vuforia Developer Portal - Licenses". Home | Engine Developer Portal. <https://developer.vuforia.com/vui/develop/licenses> (consult. 2023-06-07).
- [8] "Releases · hiagomu/ART". GitHub. <https://github.com/hiagomu/ART/releases/> (consult. 2023-06-07).
- [9] "Xcode 15 - Apple Developer". Apple Developer. <https://developer.apple.com/xcode/> (consult. 2023-06-07).
- [10] DE LACERDA, MANOEL BEZERRA. Realidade Aumentada como Motivação do Aluno para a Aprendizagem, 2013.
- [11] CARDOSO, Alexandre et al. O desafio de projetar recursos educacionais com uso de realidade virtual e aumentada. In: *Anais do VI Workshop de Desafios da Computação aplicada à Educação*. SBC, 2017.

- [12] "Realidade aumentada". Unity.
<https://unity.com/pt/unity/features/ar> (consult. 2023-06-07).
- [13] "Uma plataforma de criação de ponta a ponta". Unity.
<https://unity.com/pt/unity/features/ar> (consult. 2023-06-07).
- [14] "Vuforia Library". Getting Started | Vuforia Library.
<https://library.vuforia.com/> (consult. 2023-06-07).
- [15] BABILINSKI, Krystian. Augmented reality for developers: Build practical augmented reality applications with unity, ARCore, ARKit, and Vuforia. Packt Publishing Ltd, 2017.

