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Merged reality for everyone

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This article addresses some interesting challenges and business opportunities within the promising merged reality ecosystem, which offers the vision of bringing together virtual, augmented and physical realities, seamlessly. The article also links the current status of this field with exploratory research and development work carried out by Altice Labs.

Keywords

Mixed Reality; Augmented Reality; Virtual Reality; Natural Interaction

Introduction

Virtual reality (VR) is currently under the spotlight, with multiple big industry players truly hyperactive introducing affordable technology, sophisticated services and exciting content.

There are interesting variations and combinations of reality and virtuality along Milgram et al.'s "Reality – Virtuality Continuum" [1], spanning from the physical world to its recreation as a completely digital environment using virtual components. The middle ground is the so-called mixed reality (MR), which includes augmented reality (AR) – where virtual elements are overlaid on the physical world – and augmented virtuality – where data and video from the physical world impact the virtual environment.

Most of the applications and services in this domain are usually associated with a paraphernalia of technology, such as controllers, sensors and cameras, making it rather challenging to create a simple and pleasant user experience. Nevertheless, 360° video, low-cost display devices (including smartphone adapters), gestural and somatic interaction approaches, integrated tracking and increased mobility have been improving significantly and truly immersive experiences are now becoming possible and quite affordable.

In this article we connect the current status of this field with exploratory research and development work carried out by Altice Labs, and we address some interesting challenges and business opportunities within the promising merged reality ecosystem, which offers the vision of bringing together virtual, augmented and physical realities, seamlessly.

From virtual reality to mixed reality

Three different technologies have evolved in parallel, and are now witnessing a convergence, raising the tantalizing prospect of widespread availability as MR for everyone: VR, somatic controllers and AR.

VR was the first to emerge. After decades of trials and announcements, the technology has finally caught up with the mass market needs. Three-dimensional (3D) graphics are now commonplace, not only in desktop computing but also for handheld devices such as smartphones. For years, simply having access to 3D virtual spaces was deemed "VR". Since it is now so common, however, the term evolved. By mentioning "VR", one now expects to have the visual experience of being inside the virtual space, using immersive devices much better, convenient and affordable than the heavy and high-latency devices of the 1990s. High-end devices are now priced at the €400-€600 level of video game consoles (PlayStation VR, Oculus Rift), except some more refined alternatives (HTC Vive: €900-€1000). Low-cost devices are almost free: using cardboard or plastic assemblages, people can use their own smartphones to enjoy immersive VR. Branded solutions, such as Samsung Gear VR, cost a few dozen euros, while Google Cardboard and similar devices may cost only €5.00 or even less.

Somatic controllers (i.e., motion-based or gesture-based, for natural interaction) have matched the widespread availability of VR, both in availability and diversity of low-cost devices. Arguably the first major market success was Nintendo's Wii console controller, whose popularity caught by surprise most technology and video game media pundits, leading to a variety of competing offers, such as PlayStation Move, all based on simple acceleration tracking and visual tracking of the controller's position. In its wake, Microsoft Kinect offered full-skeleton and depth sensing for €100 and originated a cascade of application scenarios, from end-user entertainment to medical applications. The growth in media interest and business investment means that dozens of somatic controllers are now available, from Microsoft Kinect alternatives to full-body tracking suits such as PrioVR, alongside specialized devices such as Leap Motion controller for hand and

finger tracking, the Myo gesture control armband for detection of muscular activity in the arm, or spatial handheld controllers specifically designed to interact with VR spaces seen through Oculus Rift or HTC Vive. Wide adoption was the main doubt in this equation, but the surprising success of a high-range offering (PlayStation VR), which surpassed Sony's expectations [2], allows promising expectations in this regard.

There were no such doubts regarding AR popular appeal. It grew in success, step by step. Cameras on smartphones have been used from very early on to extract information from signs in the physical world, such as bar codes or their bi-dimensional variety, QR codes. For instance, QR codes have recently been used in wine bottles to strengthen the relationship with the consumers: using their smartphone, they can find out more about the wine and get wine tasting reports or access social media [3].

A classical example of AR is the Layar Reality Browser, introduced in 2009. Its development platform allowed developers worldwide to provide a multitude of layers of georeferenced data, that could be explored live with the mobile camera application (App) as points of interest in the vicinity of the user [4].

Full-fledged, animated, 3D AR has long shown its appeal to mass audiences. A major breakthrough in popularity came in 2009 when Sony launched a camera attachment to the PlayStation portable (PSP), its portable video gaming console. This attachment was bundled with the Invizimals game [5], which not only got critics' awards but also achieved large public success, warranting the release of numerous sequels and expansions. Children would seek out "invisible to the naked eye" creatures called Invizimals everywhere: on their homes, on their pets, on their clothes, using the PSP camera to track appropriate colours.

Invizimals were not, however, only creatures visible on a device's screen. Using collectable cards as markers, children would place the creature in battle positions in the physical world and then watch them battle it out in their full colour, animated glory, superimposed with the actual physical settings (**Figure 1** is a screen capture of a battle).

FIGURE 1 – Invizimals ready to battle it out in MR

Exploration and technological experimentation

Cutting edge areas often lead to the emergence of innovative ideas with the potential to satisfy new or existing market needs, to improve existing products, services, processes or the organization itself. Thus, Altice Labs has a tradition of continuously engaging in collaborative Research, Development and Innovation projects as part of a sustained strategy for technological leadership. Throughout the years, internal capabilities, creativity, experience and knowledge have been leveraged by projects and partnerships with world class universities, R&D institutions, suppliers and customers in several projects to monitor, study and explore the advances in multiple relevant areas including the above mentioned VR, AR and natural interaction.

More than just getting acquainted with technology, we have been pursuing scenarios and use cases related to promising application areas, using several internally funded exploratory

research projects to anticipate challenges and foresee opportunities.

VR was a fast pace emerging area when we started experimenting with Second Life environment, a decade ago. We explored the creation of 3D content with the University of Aveiro and the social networking and interaction aspects with the University of Trás-os-Montes and Alto Douro (UTAD). Furthermore, we worked concepts around chat bots, multimodal customer support teams' management [6] and virtual presence.

Synchronized online gymnastics, for example, may provide new possibilities for enhancing the physical and social well-being of people with restricted mobility. We went back to Second Life and OpenSimulator technology to prototype **Online Gym**, a virtual 3D platform where different users physically apart at multiple locations may attend together a workout session coached by a monitor, all of them connected over the Internet and represented by their avatars directly animated by the movement captured on the Kinect device plugged into each personal computer [7].

FIGURE 2 – Online Gym prototype used on Bang Awards installation

Furthermore, we reused the Online Gym prototype to create an installation for public interaction, in the context of an animation film festival - Bang Awards 2014, held at the Torres Vedras castle (**Figure 2**). In fact, exergame approaches created around VR avatars and bodily interaction, proved to be a great fit for well-being and eHealth scenarios: with the Instituto de Telecomunicações - Porto, we were able to further experiment with real time markerless MOCAP interaction in 3D virtual environments, creating the **Move4Health** serious/exergame for validation of the use of Kinect as a reliable device for physical rehabilitation involving large motor skills.

InMERSE is another important exploratory project carried on in partnership with the Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência (INESC TEC), with researchers from UTAD and Universidade Aberta. A set of devices was analyzed in depth, both at a functional level and under a programming perspective: Oculus Rift, Leap Motion Controller, Google Glass, Microsoft Kinect and Myo Gesture Control Armband.

The main outcome was an open source framework - the InMERSE framework [8] - for multimodal gestural input. It enables the development of gesture-controlled applications that are independent of gesture-recognition devices and gesture-recognition methods [9]. As demonstrations, two main prototypes were created: a digital signage platform and demo, based on Leap Motion interaction, and the "First Armada of India" installation [10] integrating all the aforementioned devices, around a game concept depicted in **Figure 3**, recreating a notable moment of Portuguese history and literature.

FIGURE 3 – InMERSE installation concept: "First Armada of India" game scenario

The sitting player wears an Oculus Rift VR display and takes the role of the helmsman, steering the XVth century ship with his hands, detected by Leap Motion attached to Oculus, to avert opponent attacks. The standing player is Adamastor, the mythical giant trying to sink the ship. He gets its position as a compass heading value on Google Glass and throws rocks with movements detected by the Kinect and the Myo armband [11]. **Figure 3** shows these players in the same physical space, although they could be located remotely. **Figure 4** shows the perspective of the Oculus Rift player.

FIGURE 4 – "First Armada of India" in-game prototype view

Reaching the market

Beyond the exploratory initiatives presented in the previous chapter, some of our VR and AR projects actually reached real users, making stronger evidence of the exploitation potential of these technologies.

3D Virtual Worlds has been an area with big popularity among the education community, not only by virtue of the collaborative and the social networking features, but also due to the powerful role-playing capabilities, which are particularly adequate to many professional training situations. We explored those aspects together with UTAD in projects **MULTIS** and MULTIS II, establishing an extensive set of functional, integration and organizational requirements [12] to enhance our Learning Management System – Formare – with 3D Learning functionality that was afterwards made available to some of our customers (**Figure 5**). The approach was developed as a software architecture with separation of concerns (SoC) as its core focus. This MULTIS architecture may be deployed on other platforms, laying the grounds for obsolescence-resistant deployment of virtual and gaming technology [13].

FIGURE 5 – MULTIS instance in Second Life

Rama stands for Aveiro Mobile Augmented Reality and it's an Android/iOS App for browsing points of interest in AR, map view and routes. It was a development with collaboration from Load Interactive, created for Inova-Ria in the context of National Strategic Reference Framework (QREN) project "Parque da Sustentabilidade".

MEO Go VR is essentially an extension of MEO Go to VR through Samsung Gear VR powered glasses [14]. Developed for MEO by Altice PT in collaboration with Altice Labs and Gema Digital, the solution provides a unique and immersive experience with 360° content and live television. The App features 360° videos from multiple MEO partners and its environment transports users to a virtual living room where MEO customers with the MEO Go service can watch their favourite live channels on a giant screen (**Figure 6**).

FIGURE 6 – MEO Go VR

The future is arriving

The joint success of both VR and AR technologies is causing the emergence of new services beyond entertainment. IKEA's digital catalogue App in 2014 allowed customers to see how the furniture would look like in their homes by simply placing the paper catalogue on the floor; Holition Nails App enables trials of varnish on our own fingernails; Boucheron's allows us to try out jewellery (**Figure 7**)... the list is ever-growing.

Hands-free solutions are starting to emerge, albeit still exploratory: wireless headsets such as Google Glass, Microsoft HoloLens and Meta 2 (see **Figure 8**) are trying out new ways to enable AR to be used without locking users' hands to a specific device or position in front of a camera (as in Boucheron's example in **Figure 7**). Their applications are still being envisioned and

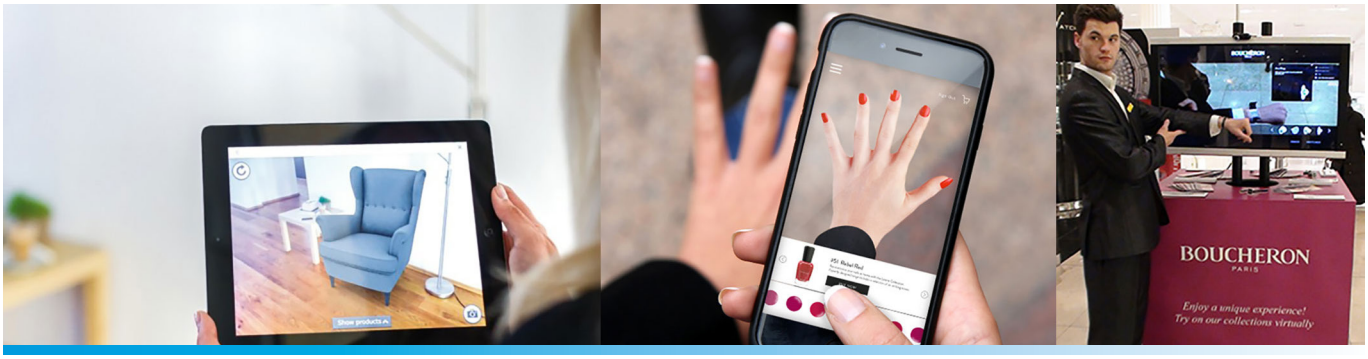

FIGURE 7 – Customer-oriented AR applications: IKEA, Holition, Boucheron

FIGURE 8 – Google Glass, Microsoft HoloLens and Meta 2 headsets

proposed, with business and industrial applications in the forefront (e.g. mechanical maintenance for manufacturing and aerospace industries), but treading the way for the future. Meanwhile, the availability of technology for indoor localization and the huge advances in mobile computer vision already made possible the debut of AR solutions to explore and navigate the complexity of underlying data and processes for management of sites, such as data centres and factories.

Industry experts project combined VR/AR revenue will reach over €100 billion by 2021, 75% being AR [15] [16]. Massification is still facing some hurdles, the first being the need for devices with the right specifications and with an affordable price target, which means high-tech headsets will be used mostly in professional scenarios for the time being. Nevertheless, recent developments show that smartphones may soon be paving the way to mobile AR widespread, with a forecast of one billion users and a market value of approximately €55 billion for the next 4 years. Terminals soon will incorporate the right features, e.g. Google ARCore, with manufacturers eager to have arguments to improve stalled sales. Developer ecosystem is spinning up, catalyzed by software platforms from major contenders, e.g. Apple and Facebook. Developers explore new capabilities and leverage the cloud, hence mobile data usage will multiply and telco will have an opportunity to add another profit stream to their 5G operations.

As interface devices become less intrusive, untethered and more intuitive, it's easy to realize scenarios being anticipated by researchers [17], with Internet of Things (IoT) and Artificial Intelligence (AI) evolving and combining with MR, profoundly disrupting and enhancing the way we perceive and explore information, manage knowledge and interact with equipment, buildings, people and the world at large.

The amazing and even upsetting concepts presented by Matsuda in his Hyper-Reality provocative and visionary movie [18] contain some glimpses of what possibly would be an ultimate Merged Reality (**Figure 9** and **Figure 10**): the physical world saturated and intertwined

FIGURE 9 AND FIGURE 10 – Hyper-Reality, speculating around the ultimate merged reality

with personalized and context-aware streams of digital media, scenarios of urban augmented communication and interaction taken to a mind-boggling extreme.

We are not going that far in making science fiction real (or are we?), but clearly a cyberspace type of near future encompasses a multiplicity of business opportunities for operators, service and content providers, in rising key areas such as AI, IoT, advertisement, micropayments, cloud and virtualization, mobility, brokerage, identity, authentication, access and security and privacy management, etc., and many of the now futuristic 5G use cases become even more relevant. Working around these scenarios is certainly part of the homework for whoever is going to stay and thrive in the digital market for the upcoming years. ■

References

[1] P. Milgram, H. Takemura, A. Utsumi and F. Kishino, "Augmented reality: A Class of displays on the reality-virtuality continuum," in *Proceedings Volume 2351, Telemanipulator and Telepresence Technologies*, Boston, 1995.

[2] N. Wingfield, "Popularity of Sony's PlayStation VR Surprises Even the Company," The New York Times, 26 February 2017. [Online]. Available: https://www.nytimes.com/2017/02/26/business/sony-playstation-vr-sales.html.

[3] R. M. P. M. d. Santos, *A utilização de QRCode na indústria vinícola*, Vila Real: Universidade de Trás-os- Montes e Alto Douro, 2017.

[4] Blippar Group, "Layar," Blippar Group, 02 January 2009. [Online]. Available: https://www.layar.com/news/blog/2009/08/29/layar-reality-browser-21-launched/.

[5] Wikipedia, "Invizimals," Wikipedia, 16 July 2017. [Online]. Available: https://en.wikipedia.org/wiki/Invizimals.

[6] L. Morgado, P. Reis, F. d. Carvalho, T. Ribeiro, P. Mestre and C. Serôdio, "Architecture for transparent helpdesk system with multimodal presence," in *IEEE International Conference in Service-Oriented Computing and Applications (SOCA)*, Perth, 2010.

[7] F. Cassola, L. Morgado, F. d. Carvalho, H. Paredes, B. Fonseca and P. Martins, "Online-Gym: A 3D Virtual Gymnasium Using Kinect Interaction," *Procedia Technology*, vol. 13, no. SLACTIONS 2013: Research conference on virtual worlds – Learning with simulations, pp. 130-138, 11 April 2014.

[8] InMERSE, "InMERSE Framework," ND, 12 April 2017. [Online]. Available: https://bitbucket.org/Apidcloud/inmerse-framework.

[9] L. Morgado, L. Fernandes, H. Paredes and F. d. Carvalho, "Separating Gesture Detection and Application Control Concerns with a Multimodal Architecture," in *14th IEEE International Conference on Ubiquitous Computing and Communications (IUCC-2015)*, Liverpool, 2015.

[10] L. Morgado, P. Cristovão, L. Fernandes, R. R. Nunes, P. Martins, H. Paredes, L. Barbosa, B. Cardoso e F. d. Carvalho, " Primeira armada da Índia: novo conceito de jogo misturando realidades aumentada e virtual, gestos finos e amplos," em *SciTecIN'15 - Science and Technologies of Interaction*, Coimbra, 2015.

[11] L. Fernandes, G. C. Matos, D. Azevedo, R. R. Nunes, H. Paredes, L. Morgado, L. F. Barbosa, P. Martins, B. Fonseca, P. Cristovão, F. d. Carvalho and B. Cardoso, "Exploring educational immersive videogames: an empirical study with a 3D multimodal interaction prototype," *Journal Behaviour & Information Technology*, vol. 35, no. 11, pp. 907-918, November 2016.

[12] L. Morgado, H. Paredes, B. Fonseca, P. Martins, R. Antunes, L. Moreira, F. d. Carvalho, F. Peixinho and A. Santos, "Requirements for the use of virtual worlds in corporate training - Perspectives from the post-mortem of a corporate e-learning provider approach of Second Life and OpenSimulator," in *iLRN 2016 - Workshop, Short Paper and Poster Proceedings from the Second Immersive Learning Research Network Conference*, California, 2016.

[13] L. Morgado, H. Paredes, B. Fonseca, P. Martins, Á. Almeida, A. Vilela, B. Pires, M. Cardoso, F. Peixinho and A. Santos, "Integration scenarios of virtual worlds in learning management systems using the MULTIS approach," *Personal and Ubiquitous Computing*, vol. 779, no. ND, pp. 1-11, 2017.

[14] MEO, "MEO Go VR," 02 January 2017. [Online]. Available: https://meogo.meo.pt/conhecer/realidade-virtual.

[15] Digi-Capital, "After mixed year, mobile AR to drive $108 billion VR/AR market by 2021," Digi-Capital, 02 January 2017. [Online]. Available: https://www.digi-capital.com/news/2017/01/after-mixed-year-mobile-ar-to-drive-108-billion-vrar-market-by-2021/#.Wag7hj75jDc.

[16] TelecomTV Tracker, "Worldwide spending on Augmented and Virtual Reality expected to double or more every year through 2021, according to IDC," TelecomTV Tracker, 03 August 2017. [Online]. Available: https://www.telecomtvtracker.com/insights/worldwide-spending-on-augmented-and-virtual-reality-expected-to-double-or-more-every-year-through-2021-according-to-idc-11230/.

[17] MIT Media Lab, "Responsive Environments Group," MIT Media Lab, 02 January 2017. [Online]. Available: https://www.media.mit.edu/groups/responsive-environments/overview/.

[18] K. Matsuda, "Hyper-reality," 02 January 2016. [Online]. Available: http://hyper-reality.co/.