AUGMENTED REALITY IN PORTUGAL: ITS USE, ITS DEVELOPMENT, AND CONTEXTS

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Abstract

The Portuguese Open Access Scientific Repositories of Portugal (RCAPP) platform allows searching and accessing various documents available in various institutional repositories and scientific journals. This set of repositories includes several Portuguese Higher Education institutions that, through these platforms, make available what has been produced by their researchers in different areas. From this portal and with reference to the last five calendar years, the year 2017 (inclusive) and until the year 2021 (inclusive), we sought to obtain information about what has been built or explored with augmented reality, trying to obtain information from these sources on what is being done with this technology in Portugal. From the results obtained, research sources (resources) related to references to non-Portuguese institutions were removed.

Thus, on May 31, 2022, an advanced search was carried out on RCAPP using the reference time period from 2017 to 2021, and two sets of words were used to carry out the search and collection. The first used the expression "*realidade aumentada*" and the second with "augmented reality." The justification for using the two expressions was related to the fact that Portuguese researchers were encouraged to write their research works in English to allow others to read their work, and this option was adopted to obtain more resources for further analysis.

With these searches in Portuguese and in English, a very similar number was obtained in terms of quantity, with one hundred and seven references being collected in Portuguese and one hundred and fourteen references in English. Subsequently, all documents were collected, which resulted in obtaining one hundred and eighty-nine files.

In a first review, it was possible to identify several scenarios where augmented reality is used in educational contexts, both from a recreational and educational perspective.

This document thus comes to show in an organized way the collection of information related to the contexts where augmented reality is used, obtaining information: that allows identifying the use of this technology, the developments she has had, and catalog this information in a summarized and organized way.

Keywords: augmented reality, Investigation, Use, Development, Contexts

1 INTRODUCTION

Ubiquitous computing, and with the meaning that it is everywhere, is a trend that is part of the reality of different embedded devices. These communication devices tend to be permanently connected online, leading to people's lifestyles being different [1]. There is thus the possibility of building different types of media, since these devices also allow hyper-realistic resolutions, advanced recognition mechanisms and video game control through movement, perpetuating that the user is always online.

The reality of each of us can be understood taking into account our perceptions of the environment around us. For example, a given unitary measure, such as temperature, can have different interpretations depending on the geographic context in which we are. Computers have helped to build assisted environments for different contexts such as medicine or video games. It is understood that assisted environments are those that can be real environments, but which have the help of technology to complement them with other information. In this way, there are several terminologies that appear in the literature, such as: virtual reality, augmented reality, mixed reality and extended reality. [2].

These "realities" are recreated through the use of devices such as cameras, sensors, screens and projection objects [2] available on most mobile communication devices [1].

To Saxena e Verma [2] these realities can be illustrated through a graphic (see Figure 1) where we have different layers. In the first element of the graphic, we have the virtual reality away/absent from our

physical reality; then there is augmented reality that worked as a layer on top of physical reality; then mixed reality, which results from the intersection of something that is built with virtual reality and augmented reality; and finally, the future, which will be what these authors call extended reality, with multiple layers of technologies that are still being developed at this time.

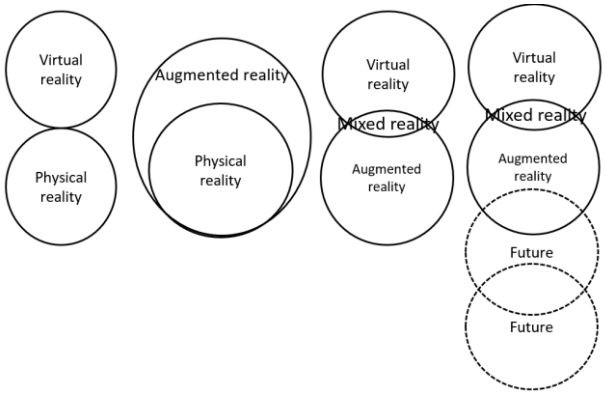

Figure 1 - Graphic representation of different realities [8]

The emphasis of this document is AR and that is technology dependent. This technology must have optical means and other sensors that allow the perception of the real/physical world with high resolution images, creating an interactive and digitized world. This perspective allows the operation to also be done by layers of information. In addition to the real world, augmented reality is also based on markers, with hyperlinks being the vehicle normally used to show information, but also GPS, the gyroscope, advanced camera models and screen resolution, combined with high-quality internet connections. speed, are the ideal tools for the implementation of applications of this type [1].

2 METHODOLOGY

The RCAPP platform allows you to search and have access to various documents that are made available in various institutional repositories and in scientific journals. This set of repositories includes several Portuguese Higher Education institutions that, through these platforms, make available what has been produced by their researchers in different areas. From this portal, and with reference to the last five calendar years, the year 2017 (inclusive) to the year 2021 (inclusive), we sought to obtain information about what has been built or explored with AR, trying to obtain data from these sources on what is being done with this technology in Portugal. From the results obtained, research sources (resources) related to references to non-Portuguese institutions were removed.

Thus, on May 31, 2022, an advanced search was carried out on RCAPP using the reference time period, from 2017 to 2021, and two sets of words were used to carry out the search and collection. The first was used the expression “augmented reality” and the second with “*realidade aumentada*”. The justification for using the two expressions was related to the fact that Portuguese researchers were encouraged to write their research works in English to allow other communities to read their work.

With these searches in Portuguese and in English, a very similar number was obtained, in Portuguese, one hundred and seven were collected and in English, one hundred and fourteen references were obtained. We then proceeded to collect all the documents, which resulted in obtaining one hundred and eighty-nine files (see Table 1).

Table 1- Distribution by years of first results

Language	**Access/Year**	**2017**	**2018**	**2019**	**2020**	**2021**
Portuguese	Free	15	18	23	16	26
Portuguese	Blocked	1	1	3	3	2
English	Free	16	14	31	17	14
English	Blocked	5	3	6	5	3

The next step was related to a first analysis of each of the files, verifying whether or not there were differences between the Portuguese and English versions (see Table 2).

Table 2 - Total documents after rectification

Language/Year	**2017**	**2018**	**2019**	**2020**	**2021**
Portuguese	14	19	24	18	22
English	15	14	24	15	12

With this step, it was possible to verify that there were some files in duplicate, that is, in contiguous calendar years they were deposited in the same repository, and there was also the case of documents with the same title, but which resulted in different files, for example for having or not having the cover of the scientific event where they were presented. There was also the case of articles that had the title in English, but the body of the text was in Portuguese. They were thus reorganized again and others removed to avoid duplication of content, resulting in a total of one hundred and seventy-seven documents.

3 RESULTS AND FUTHER WORK

The categories that were built to house each of the documents and that took into account a first analysis that was made to the summary and conclusions. In cases in which this approach was not enlightening, more sections or the entire document were read. From this stage of analysis, an index was built with a summary distribution of the contexts on which the documents focus (see Table 3).

Table 3 - Summary distribution of contexts

Summary analysis of contexts	
Augmented application in the context of a museum or similar space	Journalism, information support and paper advertising
Tourist application on the street	Journalism, the case of radio
Training support	Children's book
Support for primary and secondary education	Geographical orientation
Support for higher education	Advertising and related services
AR, relationship with art	Cognitive and motor rehabilitation
Sports activity	People's health
AR state of the art	Services: management support
Personal sensory experiences supported by AR	Services
Industry	Television, additional information
Digital games	AR development

The topics covered in 2017 were related to the development of applications in which augmented reality was used to complete information regarding certain museum spaces [3]–[7] or public spaces in certain locations [8]–[11], as well as to support physical activity [12]. There are also reports where it is applied in education settings, as a complementary tool [13]–[18]. Other cases arise and are related to the development of augmented reality, such as the development of AR in indoor spaces [19] or working together with other embedded sensor systems [20]. There are also cases of application in the area of the arts [21].

In 2018, the documents analyzed are divided between eighteen master's theses and fifteen articles and this year the topics covered in the documents were related to teaching support, basic, secondary [22]–[27] and higher [28], in their use in advertising [29]–[31], in support of the industry [32]–[37]. There were also other documents with references to other areas and a particular case of a reference in application development [38].

With the 2019 reference, there is the widest set in terms of quantity of documents, which are also divided between master's theses and articles. There are works that show the use of AR to support primary and

secondary education [39]–[45], training [46]–[48], or that document the experiences that the user manifests through the use of this type of technology [49]]–[51] and that help to realize its potential or acceptance with users. Another evidence is the various references about the development of AR [52] or proposals to complement this technology. A particular reference to the first reference that appears and that is related to digital games [53].

There was also a diverse set of documents that were collected with reference to the year 2020. Fewer than in the previous year, but also distributed among articles and master's theses (see Table 6). Those that are in greater quantity are related to applications for support in primary and secondary education [54]–[61] where the use of AR as a support resource in the classroom or as facilitators for teachers of these age groups is emphasized. . There are also references in other areas such as tourism [62]–[64], in support of cognitive rehabilitation [65], [66] and an experience with an application that aims to minimize phobias [67].

In 2021, the number of documents collected was similar to the previous year and also the type of documents was the same. This year, the highlight goes to publications that are related to museum and similar spaces [68]–[73] and also to teaching [74]–[79]. A reference related to the state of the art of AR was found [80], and again information appeared to works on the development of AR [81]–[83].

Thus, and through a summary of the documents, it was possible to verify that there is a balance related to the amount of published works by the researchers, that is, the distribution over the five years was almost always the same, which means that the AR is a topic that motivates research in Portugal. As for the contexts in which these works were carried out, more than twenty were identified, and those with the highest number of references are related to: Augmented application in the context of a museum or similar space; Support for primary and secondary education; Industry; Advertising and related services; People's health and AR development.

But it is in the context of education, museum spaces and industry where a greater number of publications appear, perhaps because and in education this tool has been used to support the teaching of certain topics and work on issues in the classroom but outside the physical spaces of Schools. Or because museums make use of this technology, and create different dynamics to attract more public and in the industry with experiences that have been carried out using headsets or similar mechanisms to help collaborators in their daily work.

The developers continue to bet on AR, and with the support of new hardware it will be possible to obtain better performances and also attract another type and diversity of applications.

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