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AUGMENTED REALITY (AR) IN PUBLIC INTERIORS

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ABSTRACT

Augmented Reality (AR) is developing technology for merging interactive virtual forms and shapes into the real-world environment. The AR products in interiors today require lightning and sometimes, spatial conditions, as well as access to some software and hardware elements, provided either by the viewer, or by the host of the location.

The study is following some public interiors of the 21st century and investigates the methods of creating and applying of AR sets in their structures. A systematization of AR versions according to the existing relations to the public interiors is presented. The focus is on the evaluation of the use of AR products in interior design, and on the future evolution.

The expected results are in the fields of architecture and interior and furniture design.

Key words: Augmented Reality, interior design, 21st century, public buildings.

INTRODUCTION

Last two decades, the concept of Augmented Reality has been broadly discussed, evaluated, and refined. According to Azuma (1997) "Augmented Reality (AR) is a variation of Virtual Environments (VE), or Virtual Reality as it is more commonly called." As explained later by Kipper (2013), AR "is taking digital or computer-generated information, whether it be images, audio, video, and touch or haptic sensations and overlaying them over in a real-time environment".

Today the application of AR technologies has been adopted in quite many designing, supporting and implementing units. The hardware elements of the AR set could include gadgets like smartphones, glasses, visors, and helmets; Head-Up and Head Mounted Displays (HUDs and HMDs) and combinations with existing screens, visual-spatial displays, and monitors; mini elements like contact lenses, virtual retina displays; and a great number of other solutions. The AR software also could be defined in various forms of content management systems, training simulators, game design engines and many more. Thus, studies on the AR applications could include analysis of the varying software approaches, the use and the work of the preferred hardware elements, the specifics of interface and perception, the functions of the technology in the areas of e-learning, e-commerce, e-services, medicine and surgery, computer vision etc.

This paper is created within the fields of interior and furniture design and includes public interiors. Usually, the term public interior refers to "environments which are part of the public sphere – state, administrative, educational, commercial, art, etc…" (Pisareva, 1999). Due to the more and more complex development of contemporary lifestyle, and the caused dynamics in the perception of categories like "inside" and "outside", I use here a broader meaning of the term, as defined by Mark Pimlott in his project "The Public Interior" (TU Delft 2020). "The more extensive definition of public interiors as the totality of spaces in which civil society can

be seen to operate … both inside and outside buildings, for the encounter and collective use of private people. These are places of sociability, entertainment, transport, leisure and commerce, as well as culture in the broadest sense.", explains Pimlott. Now, there are various principles and parameters for public space design, recommended by different authors (see for example Carmona 2019). Basic features of public interiors, usually handled in design theory and textbooks could include:

- Scale (the proportions between the space and the interior and furniture elements are related to the size of people and the expected services)
- Variety (monotonous presentation will not be adapted to the user's varying age, gender, culture, etc.)
- Connectedness (as in everywhere, it is important that the interior design provides contact between all the zones, and to other spaces, exits and entrances, networking systems etc.)
- Quest for sustainable design (this contemporary concept could be traced in human, social, economic, and other spheres)

Still, I will add two more features of the public interior design, which are followed and evaluated in professional discussions nowadays.

- Authenticity (of people, traditions, culture, materials - as the search of these all are main trends in many groups of the contemporary society)
- Personalization (broadly known also as "customization")

The fifth and the sixth features mentioned above are well known in philosophy studies but are yet not so popular in the design theory (may be as is in the sustainability concept). According to the Cambridge Dictionary (2020) authenticity is "the quality of being real or true" and is often used in the field of exploring and protecting the architectural and cultural heritage. Authentic design, and architecture are a result of authors' projects and concepts, they are then "polished" with the patina of the time in the swift development of the city environment. In broader sense, they also confront the kitsch and the mass production, and help the creation of identity of the public spaces.

The concept of personalisation is a well-known part of the era of digitization, supply, and demand, but it invades more and more fields of knowledge. The personalization could be explained as "the process of making something suitable for the needs of a particular person" (Cambridge Dictionary 2020). Within the spheres of digital services, personalization is done in steps like getting and storing personal data; offering personal service according to the gathered data; evaluating the results and changing the personal data records, and so on, repeating many times. But the personalization of services in non-digital environment includes pretty much the same: gathering the personal preferences and adapting the service to them.

The paper is following only these six qualities of the public interiors, and is not exploring the public safety issues, nor the educational or entertaining functions and their implementation with the AR.

The user's perspective on AR is accepted in the cases, examined in the study. All the mentioned six interior features could be easily evaluated, when experiencing Augmented public spaces by any visitor. Thus, the aim of the paper is to answers the following questions:

- What are the types of AR elements operated commonly in public interiors?
- Are there interior design conditions linked to the AR developments?

- How does the use of AR change the basic interior features of "scale", "variety", "connectedness", "sustainable design", "authenticity" and "personalization"?

EXPERIMENTAL METHODS

The study follows some popular international cases, but also public interiors and spaces near the venue of the University of Forestry in Sofia. The AR software technologies are checked and/or applied, using mostly inexpensive tablets, smartphones, and public screens.

Key element of the AR experience in the interior are the envisioned methods of customer involvement and the expected forms of hardware and software preparation. Some of the existing now hardware devices like laptops and glasses are owned by the customers, who carry them on the chosen places. (And not all of them do so or want to get engaged.) Other, devices like public screens and monitors are mounted in the interiors and are open for all the observers - prepared or not for the view. Most common cases are shown in Table 1, but it is important to notice that any combination of devices and methods could easily be made a set, without any harm of the real public interior.

Table 1: Public and personal AR devices.

Type of AR providing device	The device is provided by the viewer and is meant for personal use.	The device is provided by the interior owner/operator and is meant for public use.
visual-spatial displays, public screens, and monitors;		yes
smartphones, tablets, laptops, PCs,	yes	
glasses, visors and helmets	yes	yes
Head-Up and Head Mounted Displays (HUDs and HMDs);	yes	yes
mini elements: contact lenses, virtual retina displays	yes	

Pavlina Vodenova stated, that "The attention given by the society to the weaker and vulnerable people (and some of them are children) defines the stage of the development" (2019). The type of the used devices basically defines the accessibility of the AR installation (which is not visible without them). Thus, we may assume that the supplied public devices, especially the open screens and displays are a sign of sensitive and caring interior and campaigns.

But the hardware elements are also part of the technology itself and also determine the shape and scale of the visual field of the interior observer/user.

Exploring once more the experience of the viewer, three main elements of the AR observer's set could be found. These are:

- the real environment surrounding the customer.
- the device used to introduce the technology.
- and the viewer himself.

So, the AR elements and their connections with the public interiors could also be

classified according to these three elements like:

- Environmental anchors: when chosen elements or objects – visual markers or others are serving as "anchors" of the visual text: special spots of the interiors so that the AR scenes are to be projected on them.
- Frame/visor elements: the very frames or the visor field, limited by the camera lens of the customer are used to produce and place the AR elements in front of the observer.
- People: The observers themselves, or other people in the viewing area are linked with the proposed AR experience.

The classification above is done following the viewers' perspective, but not by the processes and techniques of the software developers. And of course, these are not all the possible versions of AR in public interiors, as various combinations, complex algorithms, and hybrid experiments are created even in this moment. Still the proposed categories could serve as a base of further investigation and development.

A quick explanation and evaluation of the use of these three groups of AR elements follows.

Environmental anchors

As a basic sample of the environmental type of AR creation, could serve the use of a special object – like the stone stick (sign) of the Brodie, the rabbit, mounted in the space of the park of "Playful Garden", used in the Brodie Castle, Scotland (Engine Creative 2020). Taking photos close to the sign and later using a specially designed free app, allows Brodie the rabbit himself to appear in the photo, automatically covering the field of the sign.

Many expectations are laid on the possibilities to navigate and lead a customer/observer towards useful information attaching labels and links to the interior, when developing the infusion of virtual data and the real environment. The popping AR elements of various outlooks and graphic quality have been used for more than a decade in marketing campaigns, museums, art galleries, etc. They are often attached to special items – inscriptions, products, figures, historical artifacts, scientific objects, and others. In case of a mall or market, the AR navigation could show the themes of shops, current marketing actions, promotions or offers, thus doubling or upgrading the effects of varying GPS mapping services. In case of a museum the AR labels and leaders could point on the detailed scientific data or lead the customer to places for rest, like the shown in the video of Mobidev (2018). Now, there are also many AR-based virtual manuals created to ease work education in lots of industries.

The texts of explaining or guiding in the surrounding are often reached or combined with AR translators. These are tools that are covering (masking) the existing on place texts with the virtual translations on the displays. Of course, the real-time decoding of foreign words with a (smartphone) camera (see for an early example the proposal V. Fragoso and others, 2011) can enhance the experience of services and public spaces labelled on unfamiliar language. Still, the help provided of these apps can vary – according to the viewer position (a central one results in better translation), and the library of fonts and languages (Fig. 1).

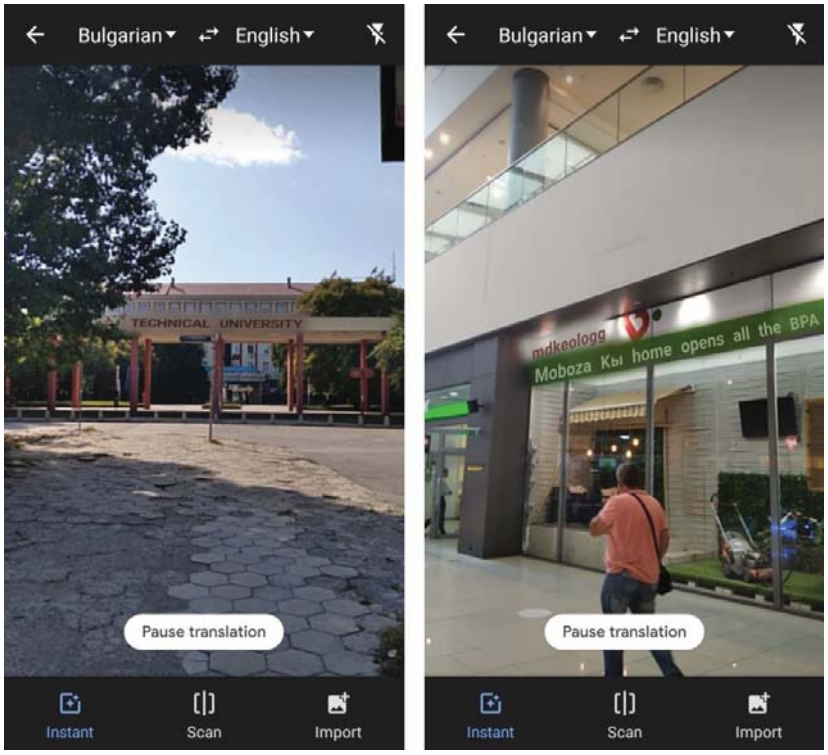

Figure 1: An illustration of real-time translation of Bulgarian to English near the Technical University Sofia, and in the Ring Mall of Sofia.

Quite an interesting effect of creating AR attached to the environment in the interior production is provided in some application of furniture shops. There, the software is designed to locate the floor, or any other horizontal surface and to place a chosen item in a 3D version inside the camera stream. (See the video explanations of Shopify 2017, or the Ikea 2019 and so on). Comparisons between some applications of such an AR forms could be found in the paper of Mihai Sandu and Ileana Simona Scarlat. (2018) for example.

Other software solutions go further in the processes and allow the users to scan the floorplan, or the interior space itself and then to fill it with new products or change it outlook. Professional drafting software companies now also offer varying CAD-to-AR (Model-to-AR and even BIM-to-AR) products, enhancing the design process. Yet, this development direction is not a part of the current research.

Comparing the AR software solutions of anchors connected to the environment, it could be summarised, that they need proper visual markers, well defined interior surfaces, sharp outlined interior volumes, and common light for the cameras. They also often require a position, where the viewer must stay – a viewpoint zone. In addition, a dedicated time for their real place/time infusion should also be expected.

As they are firmly linked to the environment, but provide "external" communication, advice and changing elements, AR anchor techniques might be defined as supporting the *connectedness*, and also the *variety* of the interior. As the AR images over the visual

markers are presented in the same way to anyone supplied with AR device, and are provided by the interior owner most of the time, they are not *personalized* in the full sense of this concept. All of this is done with minimum material engagement of the interior's owner; therefore, it could be found cost effective and *sustainable*. Moreover, because of the "physical" involvement with the interior elements, AR images usually do not change the viewers' perceiving of *size and scale.* Yet, due to the concept of implied covering (masking) of the chosen parts, these AR products do not support the existing *authenticity* of the interiors.

Frame/visor elements

Frame/ Visor AR elements are another form of virtual change of the surroundings. From the viewers' perspective, even the analogue use of artist or photographic filters, frames or embedded decorations applied on the visible field, could be defined as a predecessor of the AR based effects on the visor/display contour. Of course, AR solutions today go away beyond the filter use, although they also allow it. Contemporary AR objects are much more complex, they are projected in real-time, and could be interacted, changed, and recorded.

As popular samples of this group of AR products could serve some advertising campaigns using public screens. The AR productions there, presented the inclusion of animated elements or characters in the real environment through installation of fake windows. (See the animals in the video of JCDecaux (2012), or the falling angels in the video of AR Conference (2014), and many others).

Many games, like the popular Pokémon Go also use AR elements - often linked to the central point, or to the frames of the display field (Fig. 2).

Figure 2: An illustration of a Pokemon Go play in the street space near the University of Forestry in Sofia.

Virtual characters like the Imaginary friend (created by Nina Chanel Abney) also invade the public spaces. They can simulate movement and even verbal interaction and thus challenge the observers, provoke their movement, or support and even change their

social or spatial behaviour. An example of hybrid, both connected to the environment and to the geometry of the frame, products are the AR Google animals (Persaud, Maring 2020).

Frame/ Visor AR elements are experienced in a slightly different way than the previous group, when it comes to the public interiors. Attached to the display/visor borders, they do not need special viewpoints or shaped and defined surfaces, but still make use of the basic light. As the previously mentioned AR group of elements (covering visual markers), the AR images linked to the frame change what is to be seen and provide *variety*. They could be provided by the visitors, responding to their needs and wishes, but not following the interior owners, so that, they are more *personalized.* In addition, as they do not require efforts to change the real interior, they stay cost-effective (and thus *sustainable*). However, the connection of the animated elements to major game contexts, locations or societies cannot be accepted as *connectedness* of the interior. Moreover, the usually contrasting, playful and even absurd character of the AR images disturbs both the senses of *authenticity (purpose)* and *scale (size).*

People

Some of the most popular AR effects relate to manipulation of faces and human figures. They are mostly done when visitors take photos and videos on themselves, serving as a streaming crooked mirror. Such an examples are the TikTok applications, that can add colours, trembling, animations of magic "power", "accessories", or visual effects of fire, snow, energy rays, etc. An example of public use of similar technique is the Timberland AR campaign (Lemon&Orange 2014). There the visitors see themselves in the prepared public displays but wearing the clothes of the main shop windows.

As they are stick to the visitors and they faces/figures, these AR products take a bit of time to get loaded, but do not require any surface definitions and space scanning. The special viewpoints could be omitted (as in most TikTok effects) but also might be applied (as positions in front of public displays, etc.) The basic lightning of the space is again expected.

The senses of *scale and size* could be untouched by the manipulation of face but could also be affected when it comes to figure manipulation effects. The change of the visitors' outfits and silhouettes also do not serve the *variety* of the interior itself, neither the *connectedness* concept. Still these techniques are cost-effective, as the other AR versions and could be defined as *sustainable*. Public interiors invaded by the AR manipulated figures inevitably lose their *authenticity*. Yet, it is not sure that they accomplish fully the effect of *personalisation* towards the interior, as only the observers are visibly changed.

The presented study could not be treated as statistically relevant or fully describing the AR variations, as their range and development is rapidly growing. However, these three categories of AR elements could be now registered, observed, and analysed.

All the traced AR forms could be seen in devices, provided by visitors (or the customers) in the public interiors. The public devices like displays and screens were here found only when using AR connected to geometry of visors/frames or to the people themselves.

The key features of the public interiors embedded with the analysed in the text AR products are summarized in table 2.

Table 2: Use of AR in favour of the interior/services perceiving.

AR technology linked to: Requirements of the technology, and the effect on the features of public interiors	**Environmental anchors/ Visual markers**	**Frames**	**People/ Observers**
Is there a need of effect friendly interior for the technology performance?	Yes	No	No
Does the technology require time of the infusion to the interior?	Yes	No	Yes
Does the viewer need a special viewpoint?	Yes	No	Partially
Scale: Is the use of AR able to present properly the sense of real spaces and sizes?	Yes	No	Partially
Variety: Is the use of AR serving to varying users and needs and is it allowing parallel versions of the same public interior?	Yes	Yes	No
Connectedness: Is the use of AR enhancing the connectedness of the public interior?	Yes	No	No
Sustainable design: It the use of AR backing the concept of sustainable design?	Yes	Yes	Yes
Authenticity: Is the use of AR corresponding to the authenticity of the interiors?	No	No	No
Personalisation: Is the use of AR personalizing the way the observer experiences the interiors?	Partially	Yes	Partially

CONCLUSIONS

Many papers try to evaluate the effects of AR, creating surveys with the visitors about their levels of satisfaction. Others are quantifying the way people adapt, use, or are entertained with the presence of Augmented elements. Here I used only categories to extract not the (expected) feelings, but the design factors of the public interiors.

Looking at table 2, there are some common characteristics of all AR products. Representing quite cost-effective interior change, all of them support the concept of sustainability. In addition, all of them change the public environment in non-authentic way, infusing foreign, mass and sometimes even tacky elements, figures, colours, and effects. On the other hand, the (expected) levels of personalisation may vary according to the used technology. Only the concept of environmental anchors as found to enhance the public interior connectedness, unveiling different interior aspects, routes, and qualities. The sense of variety in the interior is not supported by the AR technology covering the people and the perception of scale is partially affected by the same technology, and even compromised by the Frame/Visor AR elements. The use of AR with environmental anchors is more obligating towards the interior, and the use of Frame/Visor elements does not need anything special.

AR technology is rapidly evolving during the last years, and inevitably invades human lifestyle more and more. Yet not all its features and tools are enhancing the public interiors or providing better perceptions or services. In addition, interior designers must

consider it – as Angelova (2019) stated "Designers [now] have to ensure the creation of products with new qualities for the customers." Why not also adapt or even fastening the changes imposed by using AR?

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