8th International Conference on Mass Customization and Personalization – Community of Europe (MCP-CE 2018)

Digital Customer Experience
September 19-21, 2018, Novi Sad, Serbia

STATE OF THE ART IN VIRTUAL REALITY SHOPS

Dinu Dragan[1], Dušan B. Gajić[1], Veljko B. Petrović[1], Milica Lazor[2], and Zoran Anišić[1]
[1]University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia
[2]DOOB Innovation Studio, Novi Sad, Serbia

Abstract: *Virtual Reality (VR) technology is becoming more available by the day to a much broader audience. Presently, VR has found its place in a wide range of human activities, such as military, healthcare, fashion, telecommunications, engineering, and business. One of the new domains of VR usage is VR shopping which enables customers to visit virtal reality shops and to browse through VR products. These VR shops enable shopping at any given time and from any location that has Internet access. Using VR shops, customers can study and manipulate 3D representation of products. They can also customize products and manipulate them into different customized sets that they can buy as a whole. Further, VR shops can also combine realistic shops with imaginary elements (no gravity, structures of fire and ice impossible in reality, and many other fantastic themes). In this paper, we will present the current state of the art in VR shopping — what types of VR shops already exist and what are they offering to their customers. We will discuss advantages and disadvantages of VR shops and VR shopping in general. The paper will be concluded with a summary of current possibilities of VR shops and an analysis of where they future may lie.*

Keywords: ***virtual reality, shopping, user experience, user experience customization***

1. INTRODUCTION

With the constant shifting of the marketplace in modern times, spurred by the ongoing revolution in communication and information technologies, the number and nature of products and services grows and shifts daily. The question arises how to stand out in this crowded environment. Thanks to the Internet, e-commerce is a fact, and while initially this notion was met with considerable skepticism[1], now the average user is entirely comfortable[2–3] buying a product or a service without ever visiting a physical location or handling the merchanidse in question. Any company without a signficant online and e-commerce presence is, at present, incapable of competing.

As technology develops, the concept of electronic shopping improves and expands. One of these expansions is virtual reality shopping. This kind of shop allows the user some of the benefits of going shopping physically—a closer contact with the product, the sense of place and context, and even the help of a guide, virtual or not—without the discomfiture of actually going to various shops.

This paper analyzes this phenomenon by considering the VR shops already implemented or demoed in the context of ubiquitous e-commerce. This paper consists of four sections. The first section is this introduction. The second introduces the concept of virtual reality as applicable to virtual shopping and discusses VR hardware and the development of the VR shopping experience. The third section outlines the examples studied. The final section presents our conclusions based on the preceeding and presents the pros and cons of the VR shopping experience and outlines possible avenues of further research.

2. VIRTUAL REALITY

The concept of virtual reality (VR) is really a broad term that covers a number of technologies a subset of which may be used to produce a user experience (UX) that mimics actually being present in a constructed reality[4]. It should be noted therefore, that VR is a UX-first technology[5]: driven by the requirements of the user's experience rather than what is technically possible. This, indeed, is what makes VR as a term so broad: it is based on an idealized imagined experience and, therefore, comprises of all technologies that bring implementations closer to instantiating that idealized imagined experience.

This paper will use VR in a much narrower sense to the sort of commercialized technologies that provide a modern implementation of a limited subset of the idealized experience, largely based on the eyes-focused-at-infinity type of display pioneered by Oculus[6]. These technologies ignore most human senses as impractical for simulation and focuses on providing an immersive, reactive 3D display, surround sound, and motion tracking for partial proprioception and sense of location.

The immersive reactive 3D display component means that the user's field of vision is filled (to within the limits of the technology used) with a simulated scene (or part of one in case of augmented reality, as will be further explained) presented in 3D which reacts naturally to the motions of the user including, first, changes of orientation of the head, and then, if possible, changes of the position of the head. This combination provides necessary immersion which divides mere viewing of a 3D image and simulated presence in another reality.

Motion tracking of this nature also helps simulate perception, as tracking the position and rotation of the head (and via some sort of controller, that of the hands and arms as well) helps the user inhabit a virtual world more fully, feeling bodily situated in this simulated reality. Finally, surround sound helps the illusion be complete providing location-appropriate sound cues for further immersion.

Virtual reality is closely related to augmented reality (AR), a concept that's quite similar in intent but considerably different in execution. The intent is in both cases that the user be transported into a fictive universe, but in the case of augmented reality this universe is based on the real one and AR technology is merely an overlay over it, augmenting it in some way. This is a promising and powerful approach that has been under constant development since the 1990s[7] to the present day[8]. While remarkable in many respects, AR is still largely limited to the flat display of a mobile phone and is rarely used in a fully immersive setting, though limited uses through mechanisms such as Microsoft's HoloLens do exist[9].

Other associated types aside from AR exist. There are virtual realities that are presented to the user at a remove: presenting a world which can only be interacted with using some set of instruments or mechanisms that mimic some real-world apparatus. The best example of this would be flight simulators which display remarkable verisimilitude but are only suitable for this specific purpose and no other. Lastly, a promising type of virtual reality is one which can be engaged with seamlessly by multiple users.

VR equipment can be summarized as consisting of a human interface device or devices (HID), an immersive display (ID), and a signal generator (SG). The HIDs provide the means by which the user controls the virtual world to the extent that it is possible. The ID serves to both display an image, frequently 3D, to the user and track the user's point of view with a certain number of degrees of freedom (DOF) in order to provide a display which reacts to the user and provides for immersion.

Lastly the signal generator actually drives the system and produces the video signal that the user observes based on the defined virtual world and the user input. These components are abstract: it is possible that all three be in one device. Indeed, in the case of AR systems, it is not infrequent that all three are the same device: a singe mobile phone which provides a virtual window to an augmented reality (thus being the ID), the interactive touch-surface which controls the simulation (thus being the HID), and generates the video signal (thus being the SG).

For pure VR, the systems available to the commercial user can be neatly divided into 'mobile' and 'desktop' variants. The mobile implementation which can be typified by the Samsung Gear VR, Fig. 1, consists of a shell with a lens assembly and some basic wiring which must have a smartphone fitted inside to operate. The smartphone is the signal generator in this instance, and together with the shell provides the immersive display. The shell can also serve as a very limited HID though these systems are not infrequently enhanced by the addition of a supplementary HID connected to the phone via Bluetooth. This supplementary HID is visible in Fig. 1 on the lower right.

Fig. 1. *Samsung Gear VR*

Other devices exist such as the Oculus Go or Google Daydream, but their substantial properties do not vary fundamentally. The benefits of this approach are that it is low-cost and, since mobile phones and smartphones have incredible levels of mobile penetration[10], presents a very low bar for user entry. The flaws are that most systems only allow for three degrees of freedom (DOF) meaning that they track the orientation of the user's head, but not any motion the user might be making. This means that looking underneath something, say, is impossible, and this curtails immersion severely. Further, the visual fidelity of the display is severely limited even on high-end smartphones since mobile graphics chip implementation must, due to issues of heat dissipation and power usage, trail significantly behind their desktop counterparts.

The desktop variant of the commercially available VR system typically consists of two HIDs designed to track the position and orientation of the user's hands (with additional options for button presses and analog input), a signal generator in the form of a PC or console, and an ID in the form of a head-mounted display (HMD) which is a display and sensors assembly which allows the user's head to be tracked with six degrees of freedom, permitting the system to take into account both orientation and position. An example of such a HMD is visible on Fig 2.

Fig. 2. *HTC Vive HMD*

The benefits and drawbacks of this approach are largely the ones of the mobile approach reversed. The level of visual fidelity is much greater, though a highly-capable signal generator is required. Further, the level of immersion is significantly greater since tracking is done with six DOF permitting free movement within some constrained play area. The flaws are that the barrier of entry is vastly higher and the cost considerable: a SG powerful enough and a matching HMD and controllers cost over $1000, more if absolutely peak performance is required. Further, such devices are somewhat heavier and more cumbersome than the mobile equivalent which may lead to user fatigue during prolonged use necessitating technological adaptation[11] though not to the level that VR cannot be used to, itself, alleviate pain[12].

Some experimental alternatives exist. An old approach that has never been successfully commercialized is room-scale VR installations[13] which leave the user unencumbered and instead use a specialized room fitted with displays on all surfaces and tracking hardware. While attempts have been made to implement this with consumer-scale hardware[14], the space requirements alone mean that this approach is only used in a laboratory setting.

Fig. 3. *VR Glove*

Lastly, current controllers (optimized as they are for gaming) are occasionally replaced with full hand tracking using a VR glove, Fig. 3, which allows for precise tracking of the hand and the position of the fingers and even, in some implementations, permits for force-feedback haptics allowing another sense to be integrated into the VR environment. This is a great boon to any system that can use such a HID, but suffers from high costs and low economies of scale.

VR shopping is, thus, constrained by the hardware limitations presented and a lot of its development in this nascent yet promising phase is tailored to the limitation of the environment it must work. Clearly, the best possible performance is desirable, but so is as shallow an on-ramp for users as possible. Section 3 will present how these challenges were met in various implemented systems, but two central approaches are to target as broad a platform as possible (for at-home VR shopping), and to target a specialized high-performance platform which is available at some central location. These two scenarios are referred to as the ubiquitous scenario and the localized scenario respectively.

The second constraint on the development of the VR shopping experience is the nature of the goods being sold. To construct a maximally difficult example, selling fragrances through VR is quite difficult given that nothing the VR can do can give the user any idea of the most important property of the product, i.e. what it smells like. In such cases, the focus can be on the propensity of VR stores not to lead to *direct* sales[15], but to still induce positive brand perception. In this case, while a VR fragrance store may not sell much directly, it may serve to enhance the overall brand appeal with the userbase. This approach to the use of VR will be referred to as ‘brand enhancement’.

However, some goods are very well suited to current VR technology, primarily those where the impression of relative size and the feeling of being bodily situated near or inside the object being sold is paramount. Therefore, as Section 3 will demonstrate, most of the work in this field is done with furniture and cars. Section 4 will try to condense the insight obtainable from this into trends in the choice of goods for VR.

3. VR SHOPPING EXAMPLES

The introduction of a new product to the market is a crucial moment in its lifecycle and one rife with potential for error. BMW made the unconventional decision to present its new X2 line of cars at the CES2018 in Las Vegas through VR alone[16].

The scenario focused on the experience of sitting behind the wheel of the car and being able to not only see what the interior was like but to also get a good sense of how its size and orientation related to the user. This was implemented using the localized scenario by providing a HTC Vive for use at the booth, Fig. 4.

Fig. 4. *BMW VR presentation, note controller*

The interactivity on offer was rich, but limited: the user could open and close the doors, open the glove compartment, explore the interior of the car, control the orientation of the seats, and so on. The sense of immersion, despite the customary lack of haptics, was such that the users were noted to carefully lower their heads when exiting the virtual car in order to avoid the roofline which, naturally, was completely insubstantial.

Outside the car, the simulation would continue, allowing the user to observe the car from various angles, and during various times of day, and (from three separate locations) view it in motion. The car’s color could also be shifted, offering a limited by convincing amount of customization.

This example does not offer a direct shopping experience but instead focuses on brand enhancement: the car is made to seem more in tune with the times by using a cutting-edge method of presenting it, and people who have explored in this innovative way are more likely to later make a purchase at a conventional showroom.

Continuing with cars, Volkswagen has made profound investments in VR technology over the years. While it has used VR to train 10000 employees[17] before and employed AR as a method for delivering a service manual[18], it first trialed the use of VR for car presentation with the T-Roc, Fig. 5.

Fig. 5. *T-Roc VR presentation, note controller free hand tracking*

Much like the BMW presentation above, it used the HTC Vive as the heart of its VR system in the localized scenario, but it also employed the LeapMotion controller which allows the user's unencumbered hands to be tracked while making natural gestures. This was used to allow the user to manipulate the car being presented using hand-gestures as well as to render the position of the user's hands within the virtual world, enhancing immersion.

The system permitted basic interaction and customization: allowing for color changes, raising and lowering the roof, and using the car horn and the radio. A similar interface was also used to manipulate the display of digital information about the car itself.

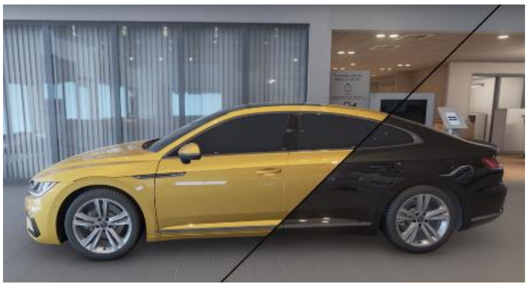


Fig. 6. *Arteon customization in VR*

This approach was later expanded with the Arteon project accomplished in association with Animech. The Arteon was, uniquely, *only* presented as a VR experience and customization was entirely done through this VR experience, Fig. 6.

Audi continues the theme of similar approaches to car-focused VR with a solution[19] based on the Oculus Rift which aims to present the user with a highly realistic experience of interacting with the car both on the outside and inside, Fig. 7, including customization.

Fig. 7. *Audi VR simulation, interior detail*

Audi's solution has a number of planned enhancements, from X-ray view (which would allow for closer inspection of the operation and mechanisms of the car), as well as the demonstration of operation, and as a special experience, a simulated LeMans 24-hour race pitstop. Evidently this is a localized scenario used for brand enhancement, as an adjunct to the traditional showroom experience and not a replacement. This is consistent with the work of other companies.

A number of companies have tried to set up a more direct shopping experience which does not concern itself with brand enhancement but instead tries to implement the ubiquitous scenario using cheaper VR systems based on mobile VR. One such example[20] is the eBay virtual store produced in tandem with Myer. This is an iOS and Android application compatible with devices of the same type as the Samsung Gear VR and, thus, focused on the in-home shopping experience, Fig. 8.

Fig. 8. *eBay VR shopping experience, item details*

The application allows the user to choose categories of particular interest and this modifies the store the user traverses so that products the user might be interested in show up more often. Details on every product are available, though only about one hundred of the most popular are available as 3D models. Further, the actual shopping is done after the tour through an external and non-VR eBay application.

A similarly general solution though one with even more ambition is the Buy+ platform implemented by Alibaba[21–22], Fig. 9. This solution is designed to work with the simplest mobile headsets meaning that a lot of faith is placed in the ubiquitous scenario and the purpose is pure shopping with little focus on brand enhancement.

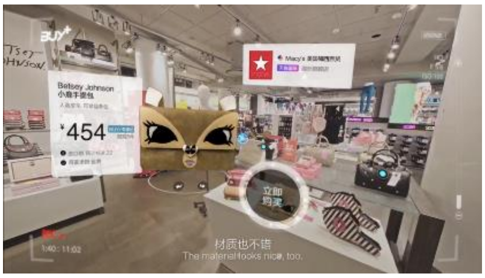


Fig. 9. *Alibaba Buy+ platform*

This bold approach has great potential but currently suffers from poor interaction (since the only interaction medium is the ID 3DOF sensor, the user has to stare for a while at an interactive object before it activates) and from a model drought: Alibaba offers untold millions of items and producing models for all of them is a process both lengthy and expensive.

Alibaba perseveres, however, and has included its Alibaba Pictures and Alibaba Music subsidiaries in the field of VR content production.

Fig. 10. *IKEA simulated kitchen*

IKEA represents a melding of the approaches seen previously, and has employed both a localized scenario aimed at brand enhancement such as its HTC Vive-adapted virtual kitchen[23] visible in Fig. 10. This kitchen is broadly interactive but is more of a showcase than a shopping experience. Much the same can be said of the video game it produced and released on Steam[24].

A move to a more shop-oriented experience is visible in IKEA's highly-localized innovation of shopping booths available in Kuwait, Jordan, and Morocco. These are meant to be, essentially, IKEA stores in miniature where a shopper may use a small set-aside space to decorate and equip with furniture one of a number of pre-set empty living rooms, an experience which includes not only the selection of furniture but also the alteration of colors and similar details. After the customization and configuration of this space is complete, the user may purchase everything they have picked out in VR or get a list they can then view in a real-space IKEA store[25].

Fig. 11. *IKEA AR furniture-placement application*

Lastly, IKEA has been working on shop-focused ubiquitous scenario implementations including a simple AR app used to see how furniture might look in a real space, presumably the user's home[26], Fig. 11. Another implementation, currently available only in highly promising demo form is a fully-realized virtual IKEA store[27].

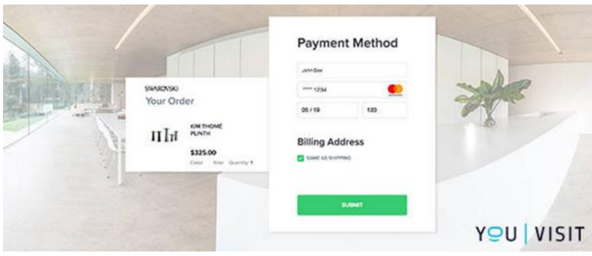


Fig. 12. *MasterCard/Swarowski collaborative VR store*

A basic implementation of this very idea is a collaboration between Mastercard and Swarowski[28] which allows the user to stroll through a well-appointed home and select (with a similar point of view tracking solution as that applied in Buy+) some item of decoration for more information: price and possibly a promotional video. With the use of the Masterpass button visible on the interface, Fig. 12, it is trivial to purchase anything on offer. This is a limited scope solution, but it serves to illustrate that a successful VR shop need not require excess complexity.

Fig. 13. *ShelfZone VR store*

Lastly, fully generic solutions are under development. InVRsion is offering ShelfZone, a generalized solution based on the HTC Vive which allows for the simulation of any store related to any brand, Fig. 13. and offers not only a full shopping experience but also user behavior tracking based on the sensors already in use in VR. ShelfZone is set to be expanded with artificial intelligence and voice-recognition functionality, and joined by a suite of related tools[29–30].

4. CONCLUSION

The level of interest in VR among large companies means that, that alone, guarantees that it cannot be safely ignored. Aside from its evident benefits, VR shopping has a number of flaws and drawbacks: high entry costs for users, 3D asset drought for companies with large inventories, and the unsolved problem of interactivity. This last element needs further clarification: while it is possible to create an interactive VR experience which mimics the experience of using a conventional shop to purchase goods, the interaction thus implemented replicates not only the good parts of shopping but also all of its drawbacks. There is something absurd about trekking across a large virtual store just to get to the next point of interest, no matter how easy the experience may be. Especially not if the user is already accustomed to the hypertextual nature of Web-based shopping which nearly any modern user is, by definition. A unified interface metaphor of VR shopping is still something that needs to be developed and universally accepted before VR shopping can fulfill even a part of its vast potential.

The best way to avoid these drawbacks insofar as it is possible is to match the needs of the good being sold with the technology being used. Broadly speaking, there are three options: high-end, low-end, and mixed goods. High-end goods include anything of a relatively high price the purchase of which is a major decision. Cars are a natural example. Low-end goods are the sorts of goods that one purchases everyday: food, clothing, gadgets and minor items of furniture and household goods in general. The purchase of one is not a major decision. Mixed goods are between these two polls and are best typified by furniture which, largely, isn't as big an investment as a luxury car, but are not a trivial one, either.

Low-end goods are best served by a ubiquitous scenario approach that implements a maximally simple shopping-first solution that sacrifices fidelity, simulation, and immersion for efficiency. Here the biggest issue for any VR shopping experience is the model drought that is likely to persist until the ease of 3D scanning at least approaches the ease by which we take photographs.

High-end goods on the other hand, are best served by using a localized scenario and implementing an immersive, high-fidelity experience that seeks to entice rather than sell via brand enhancement. Such a VR shop is not, in fact, a shop in the traditional sense but an adjunct to the showroom or exhibition. It increases the chances that the user will interact with the actual product and, thus, that a purchase will be made. This approach is only suitable for high-end goods because there the price of the VR setup is justified by the fact that even a modest increase in the likelihood of a high-end purchase repays the cost of the relevant development and hardware.

Mixed goods need both approaches to be fully effective, or one which manages to fulfill both sets of requirements. This is a challenge to implement, but perhaps shows that this mixed good area is the most fertile for the exploitation of VR technologies as a combination of VR enticement via brand enhancement may tip the user into making a VR-based purchase, combining the two approaches in one user experience.

Much research is required before the question of VR shopping can in any way be answered. Of particular interest is conducting detailed usability and user experience studies on various prototypical VR shops in order to determine using hard data their ability to influence user perceptions.

5. ACKNOWLEDGEMENTS

The reported research is partly supported by the Ministry of Education, Science, and Technological Development of the Republic of Serbia, projects TR32044 (2011-2018), ON174026 (2011-2018), and III44006 (2011-2018).

6. REFERENCES

[1] C. S. O. 2/26/95 at 7:00 PM, Why the Web Won't Be Nirvana. *Newsweek*, (1995). https://www.newsweek.com/clifford-stoll-why-web-wont-be-nirvana-185306 (accessed July 24, 2018).

[2] A. Micklethwait & P. Dimond, Alibaba: Largest Etailer on the Globe a Mere 15 Years On. *Driven to the Brink* (Springer, 2017), pp. 181–200.

[3] Y. Kim & R. A. Peterson, A Meta-analysis of Online Trust Relationships in E-commerce. *Journal of Interactive Marketing*, **38** (2017) 44–54.

[4] C. Burdea Grigore & P. Coiffet, *Virtual reality technology* (London: Wiley-Interscience, 1994).

[5] M. Hassenzahl & N. Tractinsky, User experience-a research agenda. *Behaviour & information technology*, **25** (2006) 91–97.

[6] P. R. Desai, P. N. Desai, K. D. Ajmera, & K. Mehta, A review paper on oculus rift-a virtual reality headset. *arXiv preprint arXiv:1408.1173*, (2014).

[7] R. T. Azuma, A survey of augmented reality. *Presence: Teleoperators & Virtual Environments*, **6** (1997) 355–385.

[8] M. Billinghurst, A. Clark, G. Lee, & others, A survey of augmented reality. *Foundations and Trends® in Human–Computer Interaction*, **8** (2015) 73–272.

[9] G. Evans, J. Miller, M. I. Pena, A. MacAllister, & E. Winer, Evaluating the Microsoft HoloLens through an augmented reality assembly application. *Degraded Environments: Sensing, Processing, and Display 2017* (International Society for Optics and Photonics, 2017), p. 101970V.

[10] International Telecommunications Union, *World Telecommunication/ICT Indicators Database 17th edition* (2013).

[11] S. Osman, *Pressure sensing to identify fitness and comfort of virtual reality headset* (Google Patents, 2017).

[12] C. Glennon, S. McElroy, L. Connelly, L. L. Mische, A. Bretches, A. Gard, & L. Newcomer, Use of Virtual Reality to Distract From Pain and Anxiety. *Oncology nursing forum* (2018), pp. 545–552.

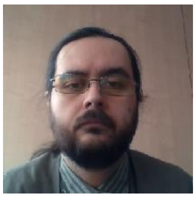
[13] M. A. Muhanna, Virtual reality and the CAVE: Taxonomy, interaction challenges and research

directions. *Journal of King Saud University-Computer and Information Sciences*, **27** (2015) 344–361.
[14] S. Schlechtweg, miniCAVE: A Fully Immersive Display System Using Consumer Hardware. *Proceedings of the 14th Eurographics Conference on Virtual Environments* (Aire-la-Ville, Switzerland, Switzerland: Eurographics Association, 2008), pp. 73–80. https://doi.org/10.2312/EGVE/EGVE08/073-080.
[15] Why VR Stores Will Be a Hard Sell | DigitalNext - Ad Age. (n.d.). http://adage.com/article/digitalnext/vr-stores-a-shopping-reality/308419/ (accessed July 24, 2018).
[16] BMW used virtual reality to bring its latest crossover SUV to CES. *Engadget*, (n.d.). https://www.engadget.com/2018/01/10/bmw-x2-virtual-reality-experience-ces/ (accessed July 24, 2018).
[17] S. Hayden, Volkswagen Group to Train 10,000 Employees in VR This Year. *Road to VR*, (2018). https://www.roadtovr.com/volkswagen-group-to-train-10000-employees-in-vr-in-2018/ (accessed July 24, 2018).
[18] Volkswagen develops augmented reality service manual for the XL1. *Engadget*, (n.d.). https://www.engadget.com/2013/10/01/volkswagen-augmented-reality-ipad-manual-xl1/ (accessed July 24, 2018).
[19] Audi brings virtual reality to showrooms. *motoring.com.au*, (2017). https://www.motoring.com.au/audi-brings-virtual-reality-to-showrooms-108682/ (accessed July 24, 2018).
[20] A. Bogle, eBay launches a world-first virtual reality department store. *Mashable*, (n.d.). https://mashable.com/2016/05/18/ebay-virtual-reality-shopping/ (accessed July 24, 2018).
[21] C. com staff, Alibaba launches Buy+ VR, AR at Maker Festival for Taobao e-tailers. (2016). https://www.cnbc.com/2016/08/03/alibaba-launches-buy-vr-ar-at-maker-festival-for-taobao-e-tailers.html (accessed July 24, 2018).
[22] Alibaba’s VR Shopping: Fad or Future? – Digital Innovation and Transformation. (n.d.). https://digit.hbs.org/submission/alibabas-vr-shopping-fad-or-future/ (accessed July 24, 2018).
[23] IKEA Launches Pilot Virtual Reality (VR) Kitchen Experience for HTC Vive on Steam - IKEA. *IKEA US/EN*, (n.d.). https://www.ikea.com/us/en/about_ikea/newsitem/040516_Virtual-Reality (accessed July 24, 2018).
[24] M. Swant, Ikea Is Stepping Into Virtual Reality by Creating a Game for New Store Openings. (n.d.). https://www.adweek.com/digital/ikea-is-stepping-into-virtual-reality-by-creating-a-game-for-new-store-openings/ (accessed July 24, 2018).
[25] Ikea’s pop-up shops offer VR shopping | Furniture Today. (n.d.). http://www.furnituretoday.com/article/548643-ikeas-pop-shops-uae-offer-vr-shopping/ (accessed July 24, 2018).
[26] L. Chang, Ikea Place, the AR app from the furniture giant, is now on Android. *Digital Trends*, (2018). https://www.digitaltrends.com/home/ikea-place-ar/ (accessed July 24, 2018).
[27] IKEA Virtual Store | IKEA Australia - IKEA. (n.d.). https://www.ikea.com/au/en/catalogue-2017/VR_Experience.html (accessed July 24, 2018).
[28] Mastercard And Swarovski Launch Virtual Reality Shopping Experience. *MasterCard Social Newsroom*, (n.d.). https://newsroom.mastercard.com/press-releases/mastercard-and-swarovski-launch-virtual-reality-shopping-experience/ (accessed July 24, 2018).
[29] ShelfZone offers VR store previews –. (n.d.). https://www.hypergridbusiness.com/2016/06/shelfzone-offers-vr-store-previews/ (accessed July 24, 2018).
[30] L. Zini, Immersive Virtual Reality solutions and product digitalization services. *InVRsion*, (n.d.). http://www.invrsion.com/ (accessed July 24, 2018).

CORRESPONDENCE

Dr. Dinu Dragan, Assist. Professor
University of Novi Sad
Faculty of Technical Sciences,
Trg Dositeja Obradovića 6
21000 Novi Sad, Serbia
dinud@uns.ac.rs

Dr. Dušan Gajić, Assist. Professor
University of Novi Sad
Faculty of Technical Sciences,
Trg Dositeja Obradovića 6
21000 Novi Sad, Serbia
dusan.gajic@uns.ac.rs



Veljko B. Petrović, MSc, Assistant
University of Novi Sad
Faculty of Technical Sciences,
Trg Dositeja Obradovića 6
21000 Novi Sad, Serbia
pveljko@uns.ac.rs

Milica Lazor, Software Developer
DOOB Innovation studio
Bulevar oslobođenja 127/V
21000 Novi Sad, Serbia
m.lazor@doobinnovation.com

Dr. Zoran Anišić, Professor
University of Novi Sad
Faculty of Technical Sciences,
Trg Dositeja Obradovića 6
21000 Novi Sad, Serbia
anisic@uns.ac.rs