

Consumer Preferences – based Online-Shopping System: Innovative Technological Approach

Jonalyn Mae E. Aranda^{1,2}, Jefferson Rey J. Arroyo^{1,2}, Muel Fred L. Ruiz^{1,2},

Abstract

Electronics commerce, e-commerce or trading enables online businesses, physical retail stores and individuals to buy and sell items on the Internet. This network permits individuals to do business without the constraint of distance and time. The existence of augmented Reality (AR) is an upgraded adaptation of the physical environment and digital visual elements used among companies involved in mobile computing and business applications. The augmented reality online commercial application was developed as an addition to the norm of webpage based content technology, where the access is available in a multitude of internet ready devices. The main objective of this study is to bring into the light the potential impact of augmented reality towards online shopping or e-commerce systems. In this study, a comparative analysis and usability study was conducted to convey the likeness and differences of augmented reality technology with virtual reality (VR) and traditional applications in e-commerce system context. Essential factors that distinguish the display and utilization capability of AR e-commerce system from each other are presented. Factors related to social, governmental or economical, limit or shape the way technology is promoted by reality, as well as consumer acceptance. A person's individual reactions and attitudes by means of how it is viewed and the observer's reference to it are compared. Large-scale adoption of AR technology may require some features and key technologies to frame as basis for future research agenda.

Index Terms: augmented reality, comparative analysis, usability study, e-commerce, effect, impact, online shopping

¹ Polytechnic University of the Philippines, Manila

² Technological University of the Philippines - Taguig
jonalynmae_aranda@tup.edu.ph

I. INTRODUCTION

The development of technology for online shopping has made its way rapidly over the Internet using a web browser or a mobile application. These online shopping websites have made shopping very convenient and have become a part of most people's everyday life since early 2000s [1]. One of the promising technology trends is the Augmented Reality or AR, and started its application or usage in the online shopping industry. AR blends the virtual and real worlds, through a virtual layer that can add images, textual information, videos or other visual elements to user's viewing of physical environment in real time [1-4].

AR typically captures real-world data, usually with a digital camera in a webcam or mobile phone. Using devices such as smartphones or tablets, wearables(headsets), projectors or fixed interactive screens, AR can provide a creative and innovative way to capture consumers' attention by enabling them to interact with virtual products [3-5]. The AR shopping experience enables consumers to interact smoothly with virtual items, see the actual product, test its functionality, check on defects, and try on the product to see if it fits him. thereby improving their visualization of products and hopefully their subsequent image of the brand, which in turn, enhances buying intentions of consumers [3, 6].

II. AUGMENTED REALITY TECHNOLOGY

The main problem of AR is establishing a stable link between 2 environments which is the Real world and the virtual environment. This technology uses several platforms to develop and push the imaginative idea of a person and bring it to life. Figure 1 shows an example of one of the famous games, Zombies, Run! In this game, the use of application by the gamer is an example of AR. To do this, mobile devices are used to represent the scenario and show an environment that combines both imaginary & real. This improves the user experience 180-degrees as

it has a wide range of applications and is appealing due to its entertainment value [7].



Figure 1: Zombie, Run! App designed using AR Technology

The use of camera and other input devices allows the user to experience AR [7,8].

The data encompasses an assortment initiator and there are three (3) usual types of initiators used to utilize AR:

1. *Initiated with Particular Visual Marker.*

This will initiate the addition of virtual images to be created upon recognition of the visual marker. For example children's books simply need to scan the card that has the identification code, and it will create the photograph of the card and come to be a three-dimensional image. The interaction with children with the aid of active stereo image, to enhance the fun of learning, this operation is quite simpler than others [8, 9].

2. *Initiated by Global Positioning System (GPS), Compass and Other Navigation Devices.*

With the use of the navigation device such as Global Positioning System (GPS), the user's location information is made known. Getting the geographic location of a person or object and linking that information in a database such as position, timing and navigation and adding enhancement information to the display at some device [8, 10].

3. *Obtain Direction Through Sensor.*

The system uses the sensor in conjunction with the gyroscope and gravity acceleration sensor on the smart terminal to find the user's speed and direction, and searches for several related updates in the database to enhance the current real-world view [8, 11].

A. Launching of Augmented Reality Technology

Augmented reality systems composed of some core components. A processor (computer), a screen and spatial sensors and/or an input device are needed, as well as a viewer (user) that observes the processed or filtered reality [11].

Failure of augmented reality technology introduced by Goggle Glass leads to assessment of inefficiency of augmented experience [12]. People who already experienced the AR technology have mentioned that it is quite overwhelming, and socially invasive, leaving the public to wonder if AR is just a trick, and no real application [13]. However, there are some users believe that through contextual awareness and ease of use, people will engage their lives to explore in the enhanced technology [14].

Microsoft HoloLens is a widely hailed wearable interface of augmented reality system that uses holograms to enable users interact in real-time period (see figure 2). Impressive headphones, gesture recognition, and native speech recognition are used to provide an in-depth experience for the user [15]. A similar headset from a company called Meta, which also apprehends the user's movement to engage and respond with augmentations [16]. Meta has a resolution of 2560 x 1440 higher than the HoloLens' resolution of 1268 x 720 [17-18].



Figure 2: Microsoft HoloLens being used for 3D Modelling

Devices such as HoloLens and Meta are already well advanced in their development and 3D modelling, also being utilized in movies, designs, stimulants, and more, buzzing around a startup that makes an AR device so realistic. The company, known as Magic Leap (shown in Figure 3), has touted its approach to augmented reality that Google (whose augmented reality technology project, Google Glass, failed to lead masses) in year 2014 of October, led an investment of \$542 million in Magic Leap [19].

The realism of the augmentations in Magic Leap's project differs from other AR interfaces. Still being safe keep are the nuts and bolts of the project until the company finds a way to innovate in more portable interface. The interface of Magic Leap will have two sections - a set of glasses which will act for the display and additional functions, and a separate processor, small in size to suit in the pocket of user [20].

Figure 3: Magic Leap's Patent

Many promising augmented reality products are expected to be deployed in the relatively near future. The Infinity AR of Europe won a recognition award in technology innovation for their ventures into augmented application [21]. The company is in the process of developing a solution to energy efficiency and cost related issue that will help the AR technology industry grow [20-21].

In the field of design and construction, another promising application for AR was developed. The interactive virtual product model and real-time application of augmented reality technology can increase context awareness in the architecture and construction and design processes. The "Initiation AR app" for Apple devices can use a 3D printer to create work and create architectural models for potential construction projects, including floor plans and environmental factors such as geographic location of the building [22].

Many companies are in gainful employment to overcome the possible downfalls of hindering the production of AR products. These problems include complications that can arise from the device's influence on the user's safety and surroundings [3, 6, 23].

III. AUGMENTED REALITY TECHNOLOGY USED IN ONLINE SHOPPING

People have basically two options in doing their purchase. It's either going to a physical store or browsing the online website and making a purchase [1, 24]. Each of the two options have its pros and cons. The traditional shopping method in physical store buyers can see the actual commodity but will have additional effort and time will be consumed as one will have to go to the physical store. In comparison, online shopping provides the comfort of being anywhere at any time, even while you are inside the bus or train, you can purchase but the biggest disadvantage of it are those fraud sellers. They tend to show great images of the product to attract customers but in reality the product is not of good quality. Despite the fact that augmented reality technology is integrated into online shopping platforms,

products can be displayed on a website in three-dimensions. Users can adjust the angle and position of products through mobile phone screen to see the overall appearance.

For instance, when users buy glasses on an online shopping platform with built-in augmented reality technology, the user opens the camera of a smartphone or computer, selects the characteristics of the desired product, and the device can capture and match face with the glasses. With this technology, it could offer a real visual experience like real glasses on your face that is easy and convenient. [25, 26].

A. Customer Brand Engagement

Recent media communication is vital technique to gain recognition. Traditional marketing with augmented reality technology is advertising marketing. This new way catches the awareness of consumers and caters the interest of the client. Augmented reality technology offers flexibility to turn product sales into leisure activities [1, 4, 27].

Firstly, augmented reality online shopping enables some attributes of consumer's appearance or idea, such as the dimensions of their homes, customer's body shape and size. This approach rationally complements to the social presence of consumers. An essential element of good consumerism is consumers' sense of social existence.

Secondly, the augmented reality online shopping determines the consumer's sense of accomplishment and consumer attitude towards the use of information about product. Innovative marketing of the glasses system of Microsoft HoloLens allow the general public experience the fun of shopping. With this type of amusement is one in every can be a source of bright outlook [28, 29].

B. Consumer's Purchase Intention

The user's purchase intentions are influenced by greater practical and sublime value of augmented technology. The product knowledge obtained through the 3D augmentation of a product positively influences consequent purchase intention, however the product knowledge provided is independent but limited in scope compared to traditional online product experiences. [30].

First, changes in consumer psychology, particularly those related to self-perception, risk, and product characteristics, are important. The psychological change is basically reflected in the interaction between consumption and its own. Previously, general online shopping only allowed consumers to imagine their own products and their relationship, while augmented reality online shopping allows yourself or your attributes and merchandise to be synchronized within the same spatial relationship [31].

Second, changes in consumer behavior - Augmented reality does not limit online shopping to advanced click-

through processes, but realizes the positive behavior of the expected shopping process through the actual nature of the purchase. This behavior reflects the shadow of modern experiential marketing. Customer satisfaction gained through a top quality experience has become one of the key tools for effective purchase [2, 3, 32].

The concept of AR developing telepresence can be a major driver of purchase intention. Awakening telepresence with an easy-to-use application enhances the augmented experience and increases buying-decision making [32-34].

C. Development of Different E-commerce System – Comparative Analysis

A comparative analysis or benchmarking was performed to differentiate and contrast the development of AR enhanced online shopping system with the traditional and virtual reality (VR) online shopping system. The three different online shopping systems presented in this research were all designed in a web page or website environment to present a clearer view of the goods or applications, as shown in Figures 4, 5 and 6 [35].

The visualization of a conventional e-commerce web page used 2-dimensional static photos of the merchandise, from various point of view, as shown in Figure 2 [36]. With a conventional online shopping website, users can scrutinize the two-dimensional photo of a product before purchasing it. Typically, images are interactively switching side-by-side, front or rear view by the user. The conventional method is by far the most commonly used online shopping approach [35].

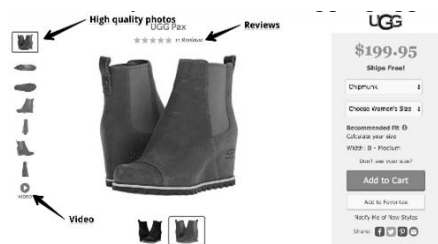


Figure 4: Traditional e-commerce in 2D image

JAVA applets were often used in virtual reality-enabled online shopping systems to embed virtual product models in real-time and provide users with functions and controls, such as translation and ability to rotate and zoom, as shown in Figure 3 [37]. With virtual reality-enhanced online shopping web content, users can easily manipulate control and choose the focus for viewing virtual product models. Virtual reality online shopping can have different layouts. [38].



Figure 5: Virtual Reality (VR) Headset, with VR-ready Laptop

In augmented reality online shopping system, consumers can view virtual products into their actual physical environments. Shown in Figure 4 is an example of an AR online shopping system running on a laptop [39].

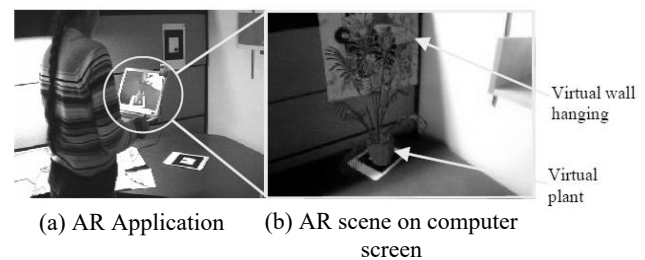


Figure 6: Augmented Reality (AR) application running on a laptop computer

With developed AR technology, users can take laptop/cellular phone and move around their environment to interpret, rotate, and zoom the virtual product model. Virtual reality e-commerce determines the interaction and select operations in traditional online shopping, and through moving of markers to position the virtual products at different interactions displayed on the device help users to assist them in the desirability to buy the product [35, 40].

Table 1 aims to empower people and future users to better understand and learn the differences between augmented reality, virtual reality, and traditional online shopping in retailing industry

Table I.
COMPARISON BETWEEN AR, VR AND TRADITIONAL
ONLINE SHOPPING IN RETAIL CONTEXT

Differences	Augmented Reality (AR) E-Commerce System	Virtual Reality (VR) E-Commerce System	Traditional E-Commerce System
Environment	Combined both real and virtual objects co-existing the same space and in real-time at physical environment.	In VR, users are fully immersive in the virtual world environment.	A typical online webpages/websites.
User View	Allows user to see the real world around him and the virtual object.	Users see the virtual environment only.	Displays a 2-dimensional static images.

D. Development of Research and Application of AR Technology in Marketing and Retailing

Wearable devices, 3D technology and mobile technology began to be developed in the year 1990 [41]. Those technology has been applied in retail, gaming, medicine, navigation and education contexts. Shown in Figure 7 is the timeline of developments in AR research, indicating the disciplinary origins of the research [35, 42].

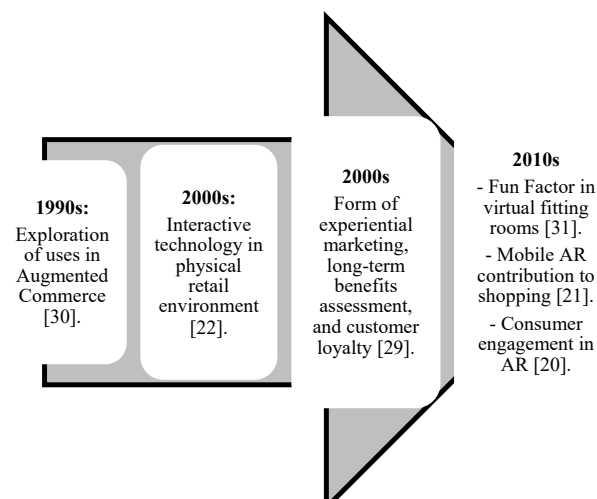


Figure 7: Timeline of Augmented Reality Technology Research

The use of Augmented Reality in retailing takes place at several platforms of the consumer point of view, in both physical and virtual approach [43]. Research regarding

the implementation of AR in retail shows that it has been considered an engaging marketing [20, 44]. In order to bridge gap between e-commerce and traditional commerce [20, 44], initial research on AR explored its use in sales expansion.

Research on AR in the 2000s was used in the physical retail environment and highlighted both practical and hedonic aspects. Virtual fitting is an early application of AR in retailing that uses a personalized or non-personalized virtual model to display the product combination on the body (as shown in Figure 8), through rotating model in front and rear view [27].



Figure 8: Animated Augmented Reality (AR) Application in Clothing Apparel – Retail Industry

It was expected that there would be a conflicting view of the long-term benefits of AR given the fact that it is perceived as a purely advertising tool, so as to create a positive relationship between consumers and brands [4, 45]. In year 2010, a study found that augmented technology was advantageous for businesses and brands, which could strengthen consumers desired to purchase a product. Traditional shopping and the adoption of augmented reality on the Internet indicate a positive response from consumers to the technology, encouraging them to interact with retailers and buy from stores that offer this technology [13, 46].

IV. METHODOLOGY

A usability study was performed to determine the utilization capability and user's experiential assessment of the designed AR e-commerce system. [47].

A. System and User Interface Design – Usability Study

Internet is the primary user interaction platform of AR e-commerce system, similar with traditional e-commerce system. However, with AR e-commerce system, a video camera is needed to capture the consumer's physical

environment and integrate it with virtual objects in real-time [47].

Primary users of the system are expected to be common computer users, with minimal computer experience. The user interface was made as simple and user-friendly as possible. In the given study, it determined that consumer shopping typically includes three main tasks [47]:

- (1) Searching for products.
- (2) Interacting with products.
- (3) Acquiring product information.

With AR e-commerce, users can have special interactions, which are not available with other applications. Users can walk around their environment, with their laptop or smartphone in order to see how a product fits in their environment from different viewpoints, as shown in Figure 9. Users can also interact with the AR scene by moving or rotating markers used for tracking [1, 47].

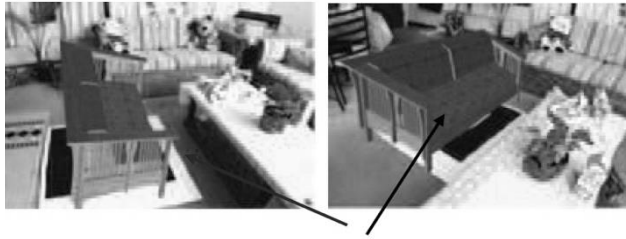


Figure 9: A virtual sofa model in a real scene

The used of large markers are for large virtual objects like furniture to make recognition, and registration easier and more reliable, as shown in Figure 10 [47]. With large markers, online consumers can bring large virtual products into their homes and view them from a distant location. Since marker tracking is based on computer vision technology, product models also need to be normalized with respect to marker size so that users can see product models in actual size [47].



Figure 10: Large Marker being used

B. Experiment Design – Usability Study

Based on a pilot user study for home furniture products [48], a formal user study was designed and conducted to test the usability of the developed AR e-commerce system. In the full study, different types of e-commerce web pages were designed for office products (wall hanging and decorative plants) to avoid product-based bias, as shown in Figure 11 [48].

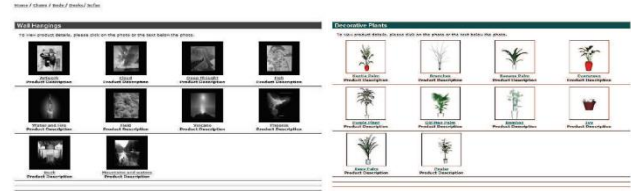


Figure 11: Office products or accessories (wall hanging and decorative plants)

In the study, the independent variables were the three different types of e-commerce system, four different environments (an open space office, a cubicle, a single-user, room office, and a multi-user single room shared office). The dependent variables in the research question were three main variables: (1) overall evaluation, (2) information provided, and (3) ease of use.

V. RESULTS AND DISCUSSION

A. Experiment Design – Usability Study Findings

To determine differences in overall evaluations for the three types of e-commerce systems, multiple mean comparisons was used. The analysis results in Table 2 show that each pair of mean overall evaluations for the three types is significantly different [48].

Table II.
OVERALL EVALUATION RESULTS

Type of E-commerce System	N	Subset		
		1	2	3
Traditional	24	2.17		
VR	24	3.75		
AR	24	4.58		
Significant Difference		1.00	1.00	1.00

In comparing the three e-commerce systems, the AR enhanced e-commerce was rated highest by users, which indicates that users preferred the AR enhanced e-commerce system more than the other two technologies [48].

Table 3 shows that the differences in information provided between the e-commerce systems are both statistically significant. Participants also mentioned that the AR e-commerce system provides the capability to see how products fit in the physical space, for them to gain more visualization information [48].

Table III.
INFORMATION PROVIDED BY THREE DIFFERENT
TECHNOLOGIES

Type of E-commerce System	N	Subset		
		1	2	3
Traditional	24	1.96		
VR	24		3.54	
AR	24			4.54
Significant Difference		1.00	1.00	1.00

The difference between the VR enhanced e-commerce system and the AR enhanced e-commerce system is not statistically significant, as shown in Table 4. On the other hand, ease of use for the traditional e-commerce system is significantly better than ease of use for the AR enhanced e-commerce system [48].

The results of analysis in the ease of use of AR technology have two viewpoints. First, AR e-commerce system uses more devices and needs more computer skills. Second, users were still not familiar with AR and its interactions. Meanwhile, there is also no significant evidence that locations has significant effects on ease of use [48].

Table IV.
EASINESS TO USE OF THE THREE E-COMMERCE SYSTEM

Type of E-commerce System	N	Subset	
		1	2
Traditional	24		4.58
VR	24	4.02	4.02
AR	24	3.48	
Significant Difference		1.00	1.00

B. Consumer's Technology adoption of AR in marketing and retailing

The significant relationship between technology and society is presently seen under the lens of “technological determinism”, and follows the natural course and society adapts to it, but there are other factors that precede it [49]. In technology adoption, both political and social factors are considered.

Ivan Sutherland's “Sketch Pad Graphical User Interface” was invented fifty years ago [6], and the consumer's view of technology acceptance is critical in producing new or replacement technology for the business' success. And within this area of research, Davis's ‘Technology Acceptance Model’ (TAM) is the most prominent model [50].

The Technology Acceptance Model (TAM) relies on a stimulus-organism-response model and is traditionally regarded as the difference between the consumers and organizations perspective in technological innovations. Key factors include the *perceived usefulness of technology* (PU) in enhancing the user's activity, and also the *perceived ease-of-use (PEOU)* of employing a particular system. In addition, a user's individual differences and characteristics and attitudes toward technology can serve as external variables that affect the user's PU and PEOU [50].

Consumers respond to AR's empirical and experiential value interactively in a good manner. The contribution and perceived usefulness (PU) of technology in order to accelerate the process of purchase decision-making in both practical and hedonic roles [51]. In particular, the level of cognitive innovation of consumers or online shoppers greatly influenced the behavior towards acceptance and utilization of augmented technology. The augmented reality enhanced online shopping system helps reduce the cognitive risk from unreliability visualizing or viewing the product and its attributes.

Furthermore, virtual interactions prior to online purchases stimulate images as they can provide information about the product that closely resembles the knowledge gained by directly examining the product [52]. AR makes it more attractive than traditional merchandising techniques because it highlights the positive consumer reaction to AR technology in the store and improves the shopping experience [53].

Overall, consumers' understanding of how to use new technology is fundamental to elicit positive feedback from users which leads to acceptance of the technologies, as PU, PEOU, by contrast, can reduce intrusions, frustration and dissatisfaction [7-8, 11, 50-53].

C. Effect of Augmented Reality

Augmented Reality is increasingly extending the usage of mobile computing and making it more widespread and ubiquitous. It also offers interaction between humans and computers, where human individuals can “enhanced” their capabilities through artificial intelligence and “strengthened” the symbiotic relationship of biological and artificial aspects [54].

The Society of Human Factors and Ergonomic has performed a research study to understand and conceptualize the vital design of principles incorporated for Augmented Reality adoption. Shown in Table 5 are the following human factors to consider with [55].

Augmented reality is the first step in making individuals more than human and recognizing interactions from both digital and biological perspectives. Still, there is an opportunity to leverage existing data (using existing AR technology) resulting in a more useful usage to the average consumer.

Table V.
FACTORS INFLUENCING ADOPTION OF AUGMENTED REALITY

Factors	Behavioral Responses
Aesthetics	Aesthetics is an important component of mass adoption.
Comfort	Determining the suitable aesthetic will heighten the desirability to interact in the device.
Contextual Awareness	Appropriate temperature, shape, weight and tightness of the device provides comfort to the user.
Customization	Consumer comfort is strongly influenced by the device’s purpose, varying greatly according to social contexts.
Ease of Use	Usage of AR devices need to define and consider by businesses or companies. In order to engage users, the device should take into account human differences in shape, size, dimensions and appearance. The interaction of AR technology should be easy and transparent for the user.

As companies become deregulated and monopolize the mainstream software on which society depends, the

daily lives are seriously affected. This could be a source of rejection in which people will be seeing as issues projected on augmented reality devices.

VI. CONCLUSION

The technology capability of a traditional e-commerce systems have reached a limitation, as they no longer provide enough information for online customers. Augmented Reality could be an area with openly conceivable outcomes and it is relatively unexplored. This study presents evidence of AR application and potential effects that change consumer preferences in the shopping system.

The usability study conducted provided a results that the AR e-commerce system could be used to provide more informative product knowledge to online customers and help them make better purchasing decisions.

The consumer’s intention or desirability to purchase an item also considered the following factors - product knowledge, hedonic, and practical value conveyed by the augmented experience. The interactive technology has advanced since the study of van Krevelen and Poelman in 2010, and Olsson and Salo in 2011 in which the results of the study concluded that the limited user applicability of technology [12-13, 17, 56].

Further research should be conducted to determine which populations could potentially benefit from AR technology, with face-to-face interviews from different groups in various industries. Also some marketing strategies for consumer technology products can be extended to other areas with a well-defined market segment to identify a more innovative AR device should target.

ACKNOWLEDGMENT

The author would like to acknowledge the support of the Polytechnic University of the Philippines in the conduct of the study.

REFERENCES

- [1] Ballantine, P. W. (2005). Effects of interactivity and product information on consumer satisfaction in an online retail setting, *International Journal of Retail & Distribution Management*, 33.6:461-471.
- [2] Nelson F (2014). The Past, Present, And Future Of VR And AR: The Pioneers Speak. Tom’s Hardware.
- [3] Strickland J (2016) How Google Glass Works. TECH.

- [4] Vacca J (2016) Bring Ideas to Life. Microsoft HoloLens.
- [5] Staff G (2016) POKÉMON GO - What You Need to Know. YouTube.
- [6] Stone J (2015) Augmented Reality - What Is It? Virtual Reality Society.
- [7] Mark LA, Rosenblum LJ, Brown DG, Schmidt GS, Julier SJ, et al. (2015) Military Applications of Augmented Reality pp: 671-672.
- [8] Nintendo (2016) Pokemon Go - Get Up and Go Trailer.
- [9] Doyle B (2016) 5 Reasons Why Google Glass Was a Miserable Failure. TECH.
- [10] Yucel IH, Edgell RA (2015) Conceptualizing Factors of Adoption for Head Mounted Displays: Toward an Integrated Multi-Perspective Framework. *Journal for Virtual Worlds Research* 8: 1-9.
- [11] Javornik A (2016) What Marketers Need to Understand about Augmented Reality? Technology, Harvard Business Review.
- [12] Jacob Konrad (2016) Augmented Reality. Prezi.
- [13] Chua G (2015) Six Augmented Reality (AR) Products That Could Change the Way We Design and Build. Infolink.
- [14] Sabelman EE, Lam R (2015). The Real-Life Dangers of Augmented Reality. IEEE.
- [15] MacKenzie D, Wajcman J (1999). The social shaping of technology. (2nded), Open University Press, Buckingham, UK.
- [16] Huang, T.-L. & Liao, S. (2015). A model of acceptance of augmented-reality interactive technology: the moderating role of cognitive innovativeness, *Electronic Commerce Research*. 15(2):269-295.
- [17] Poncin, I. & Mimoun, M. S. B. (2014). The impact of "e-atmospherics" on physical stores, *Journal of Retailing and Consumer Services*, 21(5):851-859.
- [18] Mann, M.K., Liu-Thompkins, Y., Watson, G.S. & Papelis, Y.E., (2015). A Multidisciplinary Examination of 3D Virtual Shopping Environments: Effects on Consumer Perceptual and Physiological Responses, In *Ideas in Marketing: Finding the New and Polishing the Old*. Springer International Publishing, pp. 752-755.
- [19] Lee, H.-H., Fiore, A. M. & Kim, J. (2006). The role of the technology acceptance model in explaining effects of image interactivity technology on consumer responses', *International Journal of Retail & Distribution Management*, 34(8):621-644.
- [20] Jay Y, D'Onfro J (2014) Google Is Leading A \$542 Million Investment In Magic Leap, A Crazy-Sounding Startup Building A New Way To See The World. TECH.
- [21] Azuma RT (1997) A survey of augmented reality. In *Presence: Teleoperators and Virtual Environments* 6: 355-385.
- [22] 26. Tikva P (2015) Frost & Sullivan Names InfinityAR Most Promising AR Startup in Europe. Infifty.
- [23] Chua G (2015) Six Augmented Reality (AR) Products That Could Change the Way We Design and Build. Infolink.
- [24] Gadalla E., Keeling K. & Abosag I. (2013). Metaverse-retail service quality: A future framework for retail service quality in the 3D internet, *Journal of Marketing Management*, 29(13-14):1493-1517.
- [25] Howland, D. (2016). The new realities of VR and retail, <http://www.retaildive.com/news/thenew-realities-of-vr-and-retail/414482/>, accessed: 29.05.2016
- [26] Bhatt, G., 2004, "Bringing Virtual Reality for Commercial Web Sites," *Int. J. Hum.-Comput. Stud.*, pp. 1–15.
- [27] Sanna, A., Zunino, C., and Lamberti, F., 2002, "HAVS: A Human Animated VRML-Based Virtual Shop for E-Commerce," *SCI'02 Proceedings*, Vol. XII, pp. 24–29.
- [28] Swan, J. E., II, and Gabbard, J. L., 2005, "Survey of User-Based Experimentation in Augmented Reality," *Proceedings of the First International Conference on Virtual Reality*, Las Vegas, NV.
- [29] Zhu, W., Owen, C. B., Li, H., and Lee, J. H., 2008, "Design of the PromoPad: An Automated Augmented Reality Shopping Assistant," *Journal of Organizational and End User Computing*, pp. 41–57.
- [30] Zhang, X., Navab, N., and Liou, S. P., 2000, "E-Commerce Direct Marketing Using Augmented Reality," *IEEE International Conference on Multimedia and Expo*, Vol. I, pp. 88–91.
- [31] Dempksi, K. L., 2000, "Context-Sensitive E-Commerce," *Human Factors in Computer Systems*, 2000Extended Abstracts, Apr., pp. 55–56.
- [32] Chen, A., Kao, C., and Wang, W., 2008, "Applying Augmented Reality on Consumer Garment Try-On Experience," *International Conference on Computer and Network Technologies in Education Hsin-Chu, Taiwan*, pp. 1–6.
- [33] Kato, H., and Billinghurst, M., 1999, "Marker Tracking and HMD Calibration for a Video Based Augmented Reality Conferencing System," *Proceedings of the Second IEEE and ACM International Workshop on Augmented Reality*, San Francisco, CA, pp. 85–94.
- [34] Wagner, D., and Schmalstieg, D., 2007, "ARToolKitPlus for Pose Tracking on Mobile Devices," *Proceedings of 12th Computer Vision Winter Workshop CVWW'07*, pp. 139–146.
- [35] Lu, Y., and Smith, S., "Augmented Reality E-Commerce Assistant System: Designing While Shopping," *ASME Paper No. DETC2006-99401*.
- [36] Carmigniani, J., Furht, B., Anisetti, M., Ceravolo, P., Damiani, E. & Ivkovic, M. (2011). Augmented reality technologies, systems and applications, *Multimedia Tools and Applications*. 51:341–377.
- [37] Roitman LA, Eric R (2013). The impact and tradeoffs of technology, communism and inequality in the fiction of Brave New World.
- [38] Roitman LA, Michael S (2014) The new Industrial Revolution: Manufacturing with 3D Printers and Polymer Materials in an Economy of Design, Innovation and Intellectual Property
- [39] Roitman LA, Alex T, Sebastian T (2014) Real-time visual subject tracking and classification by combining motion signal analysis and tridimensional-shape feature classifiers with group-induction boosting algorithms.
- [40] Arthur C (2010) Augmented Reality: It's like Real Life, but Better. The guardian.
- [41] Horowitz B (2014). The hard thing about hard things: building a business when there are no easy answers. Harper Collins.
- [42] Evans DS, Hagi A, Richard S (2008) Invisible Engines: How Software Platforms Drive Innovation and Transform Industries. MIT Press pp: 160-161.
- [43] Henn S (2013) Clever Hacks Give Google Glass Many Unintended Powers. NPR.
- [44] Roitman L, Shrager J, Winograd T (2017) A Comparative Analysis of Augmented Reality Technologies and their Marketability in the Consumer Electronics Segment. *J Biosens Bioelectron* 8: 236. doi: 10.4172/2155-6210.1000236

- [45] Metz C (2016). The Robots Will Steal All Our Jobs and No, They Won't Create New Ones. *Wired Business*
- [46] Daugherty, T.; Li, H. & Biocca, F. (2005). *Experiential commerce: A summary of research investigating the impact of virtual experience on consumer learning*, Society of Consumer Psychology: Online Advertising. Mahwah, NJ: Lawrence Erlbaum Associates.
- [47] Y. Lu, and S. Smith (2008) *Augmented Reality E-Commerce: How the Technology Benefits People's Lives*. Human-Computer Interaction. Intech Open
- [48] Fomenko, V. (2006). *Generating Virtual Reality Shops for E-commerce*, Ph.D. Dissertation, Vrije Universiteit Brussel.
- [49] Hughes, S.; Brusilovsky, P. & Lewis, M. (2002). Adaptive navigation support in 3D ecommerce activities. AH'2002, Malaga, Spain, 132-139.
- [50] Kato, H.; & Billinghurst, M. (1999). Marker Tracking and HMD Calibration for a Video based Augmented Reality Conferencing System, *Proceedings of the 2nd IEEE and ACM International Workshop on Augmented Reality*, San Francisco, CA, 85-94
- [51] Lefebvre, L.A. & Lefebvre, E. (2002). E-commerce and Virtual Enterprises: Issues and Challenges for Transition Economies, *Technovation* 22 (5), 313-323.
- [52] Lu, Y. & Smith, S. (2006). *Augmented Reality E-Commerce Assistant System: Designing While Shopping*, *Proceedings of IDETC/CIE'06*, Philadelphia, PA, paper number DETC2006-99401.
- [53] Cho, Y.; Im, I.; Hiltz, R. & Fjermestad, J. (2002). An Analysis of Online Customer Complaints: Implications for Web Complaint Management, *35th Hawaii International Conference on System Sciences (HISS '02)* 7, 176.
- [54] Human Factors and Ergonomics Society (2014). *Human Factors Considerations in the Design of Wearable Devices*. Sage Publications. Doi: 10.1177/1541931214581381
- [55] Howell, D.C. (2007). *Statistical Methods for Psychology*. 6th Edition. Thomson Wadsworth.
- [56] Mark L, Rosenblum LJ, Brown DG, Schmidt GS, Julier SJ, et al. (2015) *Military Applications of Augmented Reality*. *Handbook of Augmented Reality*, Springer pp: 671-706.