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AUGMENTED AND VIRTUAL REALITY IN E-COMMERCE – A SURVEY

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Abstract. *Experts see Augmented Reality (AR) and Virtual Reality (VR) as the future of the e-commerce industry. Conventional e-commerce stores although successful, provide limited options in terms of product presentations and shopping experience to the customers as compared to AR/VR based e-commerce platforms. These technologies have the potential to transform e-commerce businesses by providing customers with an immersive, enriching, satisfying, engaging, and enhanced interactive experience and finally increasing business sales. The ease, comfort, and experience rendered by these technologies along with the e-commerce platform give a reason to the customers to shop from these platforms and stay with the business brand. This research tends to survey the literature related to the application and influence of augmented and virtual reality in e-commerce as well as explains its in-depth connection with consumer psychology. Finally, it concludes by providing some implications (extracted from review) for e-commerce companies that might assist them in developing and improving their virtual/augmented reality-based systems.*

Keywords: Augmented reality, Virtual reality, E-commerce, Shopping experience, Consumer

1. **Introduction.** Technology is constantly evolving and advancing. With other currently emerging technologies, the augmented and virtual reality technologies are increasing their pace to become merged in many businesses including e-commerce to enhance consumer experience as well as to enrich the selling platform. The traditional e-commerce systems offer 2-D product presentations to the customers as well as offer limited options and flexibility to the customers. AR/VR-based systems bridge this gap by providing an improved product presentation as well as offer a more free and flexible shopping environment and experience to the customer [1]. Augmented reality is defined as a technology in which the real world and information generated by the computer are merged in such a way that, from the user's view, it becomes a single environment [2], or in other words, the real and virtual worlds are blended through a virtual layer that enhances user's view of the world by adding graphics, textual information or other digital data. On the other

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hand, Virtual Reality or VR is a technology that provides an interactive and fascinating life-like experience that is generated by a computer. The user has a VR device that makes the user focus intensely on the digital content while cutting him off the real world [3]. Initially, the VR devices were quite costly, restricting the use of technology to large companies but now the release of low-cost HMD's (Head Mounted Display) has made the VR technology affordable for the general consumer [4]. Also, the advancement in technologies such as AR/VR devices, development kits, mobile devices, and computer vision has led to an increase in AR/VR research and development [5].

The e-commerce industry has become quite mature by providing shopping facilities through the webpage and many people have already adopted this means of shopping because of the ease, comfort, and time-saving benefits. Unfortunately, many customers discard their shopping carts before making a final purchase decision due to certain concerns. Therefore, the retailers must find ways to convince the customers to buy their products by improving the shopping experience. This can be attained by providing an immersive real shopping experience employing AR/VR. Some of the e-commerce businesses have already launched VR shopping, e.g., there are virtual apps for cosmetic companies and fitting rooms for shopping fashion accessories including, apparel, shoes, and handbags that provide a 'try before buy' experience. Alibaba has an existing VR shopping facility and Amazon also plans to launch such a system while some companies are still considering an investment in VR shopping [6].

The motivation for this study is to emphasize the use of augmented and virtual reality technologies for e-commerce businesses during the pandemic outbreak, a time when most businesses find it difficult to maintain a physical connection with their customers and provide them a real and satisfying experience. E-commerce platforms, although mature online businesses, still lack to provide customers with a real life-like shopping and product experience. This paper contributes to the scientific literature by providing a review of the research related to the development of augmented and virtual reality technologies in the field of e-commerce; the application, influence, and significance of these technologies for the business as well as for the consumer. The paper also discusses AR/VR in e-commerce from a psychological perspective. Finally, the review provides some managerial implications that may assist e-commerce companies in developing and improving the VR/AR technology systems. Figure 1 gives a taxonomy of the material presented in this paper.

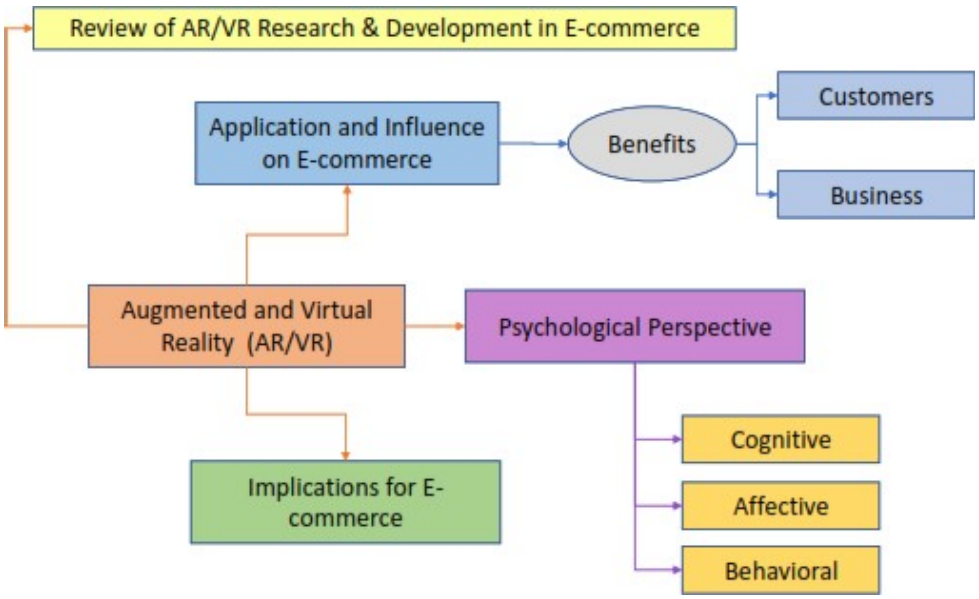

FIGURE 1. Taxonomy of the review of augmented & virtual reality in e-commerce

The rest of the paper is organized as follows. Section 2 of the paper provides a review of the literature related to the recent research and development of AR/VR in e-commerce. Section 3 highlights the application of reality technologies in the context of some e-commerce solutions such as virtual handbag shopping, and fashion retail, as well as mentions the significance of these technologies for e-commerce business and consumer. Section 4 examines augmented and virtual reality in e-commerce from the psychological perspective. Section 5 provides some useful implications, for e-commerce companies planning to deploy these technologies in their business. Section 6 concludes this paper by giving some directions for future work.

2. **Review of Related Work.** This section gives a review of the literature related to the research of augmented and virtual reality in e-commerce.

[1] conducted survey research on the use of virtual reality in e-commerce reflecting on various benefits that customers can enjoy and gains that the companies can achieve with VR technology deployment. From the financial point of view, VR based e-commerce is low-cost as compared to VR based systems for flight simulators, military, video games, etc. [1] also mentioned some disadvantages of the technology like higher marketing costs, increased quality expectations from users' side as well as an extended amount of time required for system development.

[7] proposed and tested a theoretical research model to find out how people engage with interactive technologies like chatbots and augmented reality interactive technology and what are the resulting peoples' behaviors towards the e-commerce platform or the retailing company. The researchers applied theories such as Theory of Conversation (ToC) and Partially Observance Markov Decision Process (POMDP) from the Human-Computer Interaction (HCI) field to fulfill the research objectives. The results of this study indicated that augmented reality is more interactive, provides more engagement to the customers, and results in more positive behavior towards buying as compared to chatbots. However, the study recommends chatbots be used as a complementary tool for information and communication with the purpose to respond to customer queries regarding a company's products or services.

[8] developed a research model to evaluate and compare consumer interaction with the IKEA Place app and IKEA mobile website. The conceptual model of this work exhibits augmented reality features measured by interactivity, system quality, product informativeness, and reality congruence as the independent variables which have a direct link with the affective and cognitive responses of the consumers and an indirect relation with the behavioral responses. In this study, the affective responses are measured by immersion, enjoyment, and product liking while the cognitive responses are measured by media usefulness and choice confidence. The resulting behavioral responses are measured by the customer reuse and product purchase intention. The augmented reality application features trigger affective and cognitive responses that in turn influence the customer buying behavior. The results of this study indicated that the augmented reality-based shopping system IKEA Place app provides an enhanced enjoyment and feelings of immersion as compared to the conventional web-based app.

[9] surveyed several sensor-based and vision-based tracking techniques that are used in AR applications. Tracking techniques are used by AR apps to track the users' viewpoint. In sensor-based tracking, the camera's motion is tracked using sensors that can record signals when real objects move. The sensors may be of various types including magnetic sensors, acoustic sensors, optical sensors, and inertial sensors. The vision-based tracking methods employ computer vision methods to do tracking of real-world objects. The well-known vision-based tracking techniques are either classified as marker-based (image detection-based) or marker-less tracking techniques. Certain techniques are used for marker-based tracking including monomodal and multimodal tracking, fiducial-based

tracking, extended Kalman filter, optical tracking, etc. Each technique has its pros and cons. Some marker-less techniques utilize Computer Aided Drawing (CAD) for tracking purposes.

[10] conducted detailed research on the design and implementation of apparel fitting applications based on augmented reality for e-commerce websites and developed a prototype model utilizing the marker-based visual tracking techniques. Cloud services and technologies such as ARCloud are used in this work for application configuration. Other tools used in this work include Unity that supports the AR framework. MARS (Mixed and Augmented Reality Studio) is another technology from Unity. Google's ARCore is used for motion tracking and light estimation and Apple's ARKit for body tracking and face recognition.

[11] proposed a framework called 3DR3CO that provides a personalized VR shopping experience based on consumer preferences to attract the consumer resulting in making the purchase intention. The framework consists of four stages: observe customer navigation, engage consumer interaction, consumer behavior data analysis, and re-integrate the shop design to personalize the shopping experience to the consumer to encourage purchase intention. In the first stage, the tools are developed for tracking the consumer interaction with the v-commerce website. These tools observe the gaze position and eye behavior patterns of the consumers and allow to have data about the website contents that got consumer attention. This data can be used to create a personalized experience for the consumer. The second stage of the framework consists of extracting user purchase behavior data by using qualitative interactive tools like ratings and surveys to get user feedback. In the third stage, the data obtained from the first and second steps is examined and analyzed to find out the elements of VR shop that led to the purchase intention. The fourth and final stage is the data-driven redesign of the VR shop based on insights from consumer data.

3. **Applications and Significance of Reality Technologies in E-Commerce.** VR/AR in e-commerce is still in its early developing phase. Table 1 lists some of the developments of the technology in the e-commerce domain. The interaction of the consumer with webpage environment and 3D virtual environment induces different shopping experiences through a different stimulation [12]. An augmented reality system for the online shopping of handbags was developed by [13]. Through a TV screen, the customer can try different handbags to see which one looks the best. It also provides features such as rotation to view it from different angles as well as try it in different positions and poses.

VR also provides experiences from a home furnishing perspective, for example, the customers can view the furniture item and interact with it. IKEA's augmented reality application can measure the dimensions of the real-life room captured through the device camera and then choose the right furniture relevant to the actual room setting [2].

US virtual technologist ModiFace, a digital cosmetic company, addresses the issue of providing a personalized customer experience in the context of the cosmetic industry. The company has utilized the augmented reality technology to develop a virtual mirror that simulates the effects of makeup, facial products, teeth whitening and, anti-aging products to offer the customer a more practical and real shopping experience [2].

The virtual fitting room is a well-known concept in the realm of AR/VR technology. This concept attempts to bring an actual fitting room concept into the online environment to enhance user experience and allow customers to select appropriate clothing sizes [14]. To use the virtual fitting rooms, the customers are required to use their device camera to see on the computer how well a dress looks on them.

An e-commerce virtual dress fitting visualization solution known as Webcam Social Shopper was developed by a well-known software company, Zugara [22]. Zugara uses

Table 1. E-commerce VR/AR applications

VR/AR application	Reference
Handbag shopping	[11]
Virtual fitting room	[12]
Sunglasses and watches	[14]
Virtual cloth fitting	[10]
Fashion retail	[17]
PromoPad: Shopping assistant	[18]

certain technologies for AR/VR software development like ARKit, ARCore, gesture and facial recognition, and motion capture.

Alibaba e-commerce has introduced an AR-infused shopping environment that offers an interactive experience that is not only enhanced but also easy to use. Paint retailer Dulux provides an application that customers can utilize to see a variety of colors on their walls and choose the one that looks best while buying the paint [15].

Research by [16] evaluates how effective is augmented reality for e-commerce by using products like sunglasses and watches. The results proved that VR/AR provides benefits by introducing novelty, originality, deep involvement, entertainment, and usefulness, that further results in the likely attitudes of customers towards intention to purchase the product and finally influences the purchase decision.

The use of VR/AR offers several benefits to the customers. For example, shopping in AR/VR supported environment is close to the real-world shopping experience, as the customer can virtually walk and move around the store. It also satisfies the emotional and social needs of the customers by offering a visually attractive experience and people interaction [3]. For the business, the significance of VR/AR deployment in e-commerce offers a competitive advantage by attracting more customers, providing them with an enriching and immersive experience, and making the customers stay with the brand, thereby, increasing the sales and adding to the business value.

4. **VR/AR in E-Commerce: The Psychological Perspective.** Regarding psychology, a human experience generates or provokes three different states: an affective state that is related to feelings/emotions, a cognitive state that is related to belief/knowledge, and a conative or behavioral state that defines the influence of attitude on the action [23].

[19] proposed a conceptual framework for measuring the relation of emotions, discomfort and appraisal (Affective elements) with presence and brand recall (Cognition elements) to determine the overall influence on purchase intention (Conative element). The results indicate that emotions must be aroused to encourage a reasonably satisfying cognitive state of the consumer and it has a direct link with the intended behavior.

The results of another study on the virtual fitting room model by [14] explain that usability with the emotional construct has an impact on the customer usage intention. Another very interesting study by [20] explores the relationship between the sense of presence induced by virtual reality and user emotions. The researchers experimented with three virtual park environments. All three parks share the same entities and items including trees, plants, light bulbs, summer cinema, etc. However, an individual experience was affiliated with each of the parks by controlling sound, changing music, varying lights, and applying different textures. Two of the parks were modified with audio-visual effects to induce emotional states of anxiety and relaxation. The third park was kept neural and natural. The results confirmed that interaction with an anxious environment produced anxiety while interacting with the relaxing environment produced a feeling of

relaxation in the users. Also, a bidirectional relationship was found between presence and emotions meaning emotional environments provide a greater feeling of presence and vice versa.

5. **Implications for E-Commerce.** This research came across valuable implications for e-commerce companies who are considering and planning to introduce VR/AR technology in their businesses.

i) There is a need to develop engaging, interesting, and stimulating virtual technology environments. These platforms should be capable of evoking positive emotional responses because appealing virtual environments produce a deep feeling of immersion and presence. It also supports other cognitive responses like the brand recall that influences purchase intention and finally customer decision to purchase product [19].
ii) Retailers who are considering implementation of the augmented or virtual reality technologies must first decide which type of technology to implement being aware of the pros and cons of each, the equipment required to use the technology, and its suitability to business [15]. Several immersive technology options are available these days including augmented reality, virtual reality, mixed reality (a combination of augmented and virtual), and extended reality (a combination of augmented, virtual, and mixed reality).
iii) When a user interacts with a virtual fitting room application, there must be stimulation of positive emotion and perception towards the application so that the user makes an intention to use the application and make a purchase [14].
iv) Before deploying the virtual reality-based system, it should be ensured that the system is safe, secure, and comfortable for the customer and offers him a good physiological experience [21]. Experts suggest that it is very important to reduce the user's dizziness (if exists) and the problem of lost directions (if applicable) as well as support his ability to change orientation in a virtual reality system without confusion.
v) [19] recommends the integration of engaging interactive features combining the virtual and augmented reality technologies, and social media websites, like Facebook and Twitter.
vi) Cognitive factors such as deep involvement and increased interaction demand due consideration when designing virtual environments [20].
vii) E-retailors should consider improving product informativeness as well as increase the interactivity as it results in an increased product liking by the customers [8].

6. **Conclusion.** The study provides an introduction, contribution, significance, and influence of the augmented and virtual reality technologies in the field of e-commerce by conducting a literature survey. It briefly describes how these technologies are influencing both businesses and customers. It also highlights the importance of considering the psychological factors in the design of reality technology-based systems. Finally, it provides certain implications for e-commerce companies.

In the future, this study can be extended and enriched by adding more recent and timely research works on AR/VR development in e-commerce which could improve the implications section also. Secondly, a standalone qualitative or quantitative research can be conducted focusing solely on the psychological perspective of AR/VR in e-commerce.

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